Memorandum 84660

...of Recorded Gust and ...Accelerations and Derived ...ties for Airplanes in the ... General Aviation Prog...

ERRATA

NASA Technical Memorandum 84660

Tabulations of Recorded Gust and Maneuver Accelerations and Derived Gust Velocities for Airplanes in the NASA VGH General Aviation Program

Joseph W. Jewel, Jr.

September 1983

This errata is issued to correct errors introduced in the writing and production of this paper. Please make the following changes:

Page 3, under "Twin-engine executive," the first two lines of "Airplane type":

Change 1,2,2A,3 to $1,2,2A,3^{1}$.
Change $1^{1},1^{2},1^{3},3^{1}$ to $1^{1},1^{2},1^{3},3$.

Page 4:

Under "Personal," the first line of "Airplane type":
Change $10A,10A^{1},12,12^{1}$ to $10^{1},10A,12,12^{1}$.

Under "Commercial survey," the first line of "Airplane type":
Change 4,25,27 to $4^{1},25,27$.

Page 10, the second table, under "Instructional operations for airplane type": Change airplane type 19 to type 18.

Page 11, under "Commercial survey operations for airplane type": Change airplane type 4 to 4^{1}.

Page 13, under "Twin-engine executive operations": Change the value at an Incremental normal acceleration of 0.5 to 0.6 from 208 to 203.

Page 14, under "Personal operations":

Change airplane types 10A to 10^{1} and $10A^{1}$ to 10A.
Change flight hours for airplane type 10 from 225 to 224.

Page 15:

Under "Commercial survey operations," airplane type 24^{5}: Change the value for nautical miles from 13 302 to 12 302.

Under "Commercial survey operations," airplane type 17^{1}: Change the value at Incremental normal acceleration of -0.6 to -0.7 from 37 871 to 17 406.

Page 19:

Under "Personal operations": Change airplane type 10A to 10^{1} and $10A^{1}$ to 10A.

Under "Personal operations," airplane type 10: Change the number of flight hours from 255 to 224.

Under "Instructional operations," airplane type 17: Change the number of flight hours from 813 to 812.

Page 20, under "Commercial survey operations," airplane type 24^{5}: Change the flight hours from 86 to 85.

Page 23, under "Single-engine executive operations":

Airplane type 8A, change base home state from MI to MT.
Airplane type 9, change average pressure altitude from 5 539 to 4 539.

Page 24, under "Personal operations":

Change airplane type 10A to 10^{1} and $10A^{1}$ to 10A.
Change flight hours for airplane type 10 from 225 to 224.
Change average V for airplane type 13 from 95 knots to 96 knots.

ISSUE DATE:

NASA Technical Memorandum 84660

Tabulations of Recorded Gust and Maneuver Accelerations and Derived Gust Velocities for Airplanes in the NASA VGH General Aviation Program

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**Scientific and Technical
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1983

SUMMARY

Gust and maneuver acceleration data in 0.1g intervals (above preselected threshold values) and derived gust velocities in intervals of 4 ft/sec are presented in tabular form for 95 general aviation airplanes based throughout the continental United States. The sample represents 35 286 hours of flight data obtained from airplanes involved in 9 types of operations.

INTRODUCTION

In the latter part of 1960, a request was made to NASA by the Federal Aviation Administration to establish a data collection program on airplanes in the general aviation category. The purpose of the program was to update information on the flight loads - gust and maneuver accelerations - and on the airspeed and altitude operating practices of modern general aviation airplanes. Such data were needed because of the significant advances made since World War II in propulsion and aerodynamics, which have allowed modern airplanes to fly in speed and altitude regimes not obtainable by older aircraft.

Accordingly, a program identified as the NASA VGH General Aviation Program was initiated in 1961. The program was conducted on a voluntary basis; that is, participants were compensated only for the installation or removal of government-furnished flight recorders. The first data from the program were received in 1962, the last in 1981, and the program was terminated in 1982. During the period the program was active, 42 155 hours of VGH data were collected from the 105 airplanes flown in twin-engine executive, single-engine executive, personal, instructional, commercial survey, aerial application, aerobatic, commuter, and float types of operations throughout the continental United States. Of these data 35 286 hours from 95 airplanes have been evaluated and are presented in this report in tabular form for each type of operation. The tables give distributions of the incremental gust and maneuver accelerations in 0.1g intervals (above preselected threshold values) and distributions of derived gust velocities in intervals of 4 ft/sec for each airplane. The average true airspeed, the average pressure altitude, the number of flights, the flight hours, the nautical miles flown, and the state in which the airplane was based are also presented for each airplane.

This report provides a compilation of recorded acceleration and derived gust-velocity information, representative of that experienced by present-day general aviation airplanes, for use by industry and the government in establishing design criteria; no analysis of the data is given.

SYMBOLS

a_n	incremental normal acceleration (normal acceleration -1.0), g units
c	wing chord, ft
g	acceleration due to gravity, 32.2 ft/sec^2

K_g gust factor, $\frac{0.88\mu_g}{5.3 + \mu_g}$ (from ref. 1)

m slope of lift curve per radian

n_g gust limit load factor

n_m maneuver limit load factor

S wing area, ft^2

U_{de} derived gust velocity, $\frac{2Wa_n}{K_g\rho_o V_e mS}$, ft/sec (from ref. 1)

V true airspeed, knots

V_C design cruising speed, knots

V_D design dive speed, knots

V_e equivalent airspeed, ft/sec

W airplane weight, lb

μ_g airplane mass ratio, $\frac{2W}{m\rho cgS}$ (from ref. 1)

ρ air density, $slugs/ft^3$

ρ_o air density at sea level, $slugs/ft^3$

INSTRUMENTATION

The data were collected with NASA VGH flight recorders described in reference 2. The instrument consists of three main parts: a base containing the recording elements, a film drum, and a remote acceleration transmitter. The film drum contains a 175-ft roll of recording photographic paper, which is driven at a rate of about 0.5 in. per minute to obtain a time-history record of normal acceleration, indicated airspeed, and pressure altitude. The accelerometer was rigidly mounted within the range of travel of the airplane center of gravity. To obtain a continuous record of the instrumented airplane's operations, power supplied to the recorder was obtained through the master switch, so that the recorder and associated instrumentation were activated from engine start to shutdown. Figure 1 is a photograph of the NASA VGH recorder, and figure 2 is a sample VGH record for a typical flight.

PROGRAM DESCRIPTION

To provide acceleration and derived gust data representative of that experienced by current general aviation airplanes, it was necessary to select airplanes and operations throughout the United States (fig. 3) that were typical of present usage. Table I gives pertinent physical and design characteristics of the instrumented airplanes. Physical characteristics were obtained from the manufacturer, from Jane's

All the World's Aircraft, or from the specifications sections of various Aerospace Forecast and Inventory issues of Aviation Week and Space Technology. Design information that would be helpful in data analysis was obtained from the aircraft manufacturer, or calculated using references 3, 4, or 5. Each specific airplane type was assigned a number, and different models of that type were assigned a letter designation after the number.

Types of airplane operations selected to represent general aviation usage are as follows: twin-engine executive, single-engine executive, personal, instructional, commercial survey, aerial application, aerobatic, commuter, and float. Although type of operation generally defines the mission the instrumented airplanes were involved in, a more detailed definition of their missions could be useful for data interpretation. The following tabulation of operations gives: the airplane types involved in the operation, the airplane operator (individual, company, fixed-base operator, etc.), and the primary use of the airplane in the data sample. When there were two or more airplanes of the same type or model, a numerical superscript was used to distinguish one from the other. Note the use of the same airplane type and model in different operations.

Twin-engine executive:

Airplane type	Operated by	Primary use
1,2,2A,3	Companies	Business flights
1^1,1^2,1^3,3^1	Airplane manufacturers	Flight demonstration; executive transport; cargo carrier
4 and 5	Fixed-base operator	Charter flights; transition to heavier aircraft; instrument flights; and check flights
5^1	Individual	Ambulance; business; pleasure

Single-engine executive:

Airplane type	Operated by	Primary use
6,7C,$7C^1$,9	Individuals	Business and pleasure flights
7,7A,7B,8A	Companies	Business and cargo flights
8,$8A^1$,9A	Fixed-base operator	Charter flights for personnel and cargo; instrument check flights; transition to heavier aircraft

Personal:

Airplane type	Operated by	Primary use
10A,10A[1],12,12[1], 12[2],12[3],12A, 13,13[1]	Flying club	Pleasure, business, and instructional flights
10	Individual	Pleasure and business flights
11	Fixed-base operator	Pleasure, business, and instructional flights

Instructional:

Airplane type	Operated by	Primary use
12B,15,16,17, 18,18[1]	Fixed-base operator	Basic flight instruction
12B[1],12B[2],14, 14A	University	Basic flight instruction
4A	University	Twin-engine basic and advanced flight instruction; instrument instruction

Commercial survey:

Airplane type	Operated by	Primary use
4,25,27	Contracted for by U.S. Forest Service	Lead planes for retardant bombers; checks for excessive turbulence; marks drop site
9B	Contracted for by U.S. Forest Service	Scouts for forest fires; transports cargo and personnel
23	U.S. Forest Service	Smoke jumper for fire fighters; personnel and cargo carrier
19,19[1],20,20[1],21, 22,24,24[1],24[2], 24[3],24[4],24[5]	Contracted for by U.S. Forest Service	Drop retardant on forest fires
6A,17[1],26	Gas and oil pipeline companies	Pipeline patrol over level and mountainous terrain
28	Individual	Fish spotting for commercial trawlers

Aerial application:

Airplane type	Operated by	Primary use
29, 29[1], 30, 30[1], 30[2], 30A, 31, 32, 32[1], 32[2], 33, 33[1], 33A, 33A[1], 33A[2], 34, 34[1], 34[2], 35, 35[1], 35[2], 36, 36A, 37, 37[1]	Individual and company	Disperse chemicals for control of herbs, pests, and insects on farmlands
34[3]	State	Disperse chemicals for control of herbs and insects on lakes and streams

Aerobatic:

Airplane type	Operated by	Primary use
38	Fixed-base operator	Aerobatic instruction and practice

Commuter:

Airplane type	Operated by	Primary use
39,40	Commuter airlines	Passenger flights; test and check flights

Float:

Airplane type	Operated by	Primary use
41	Fixed-base operator	Personnel and cargo charter; bush type of operations

PRESENTATION OF DATA

Comments pertinent to data in tables II, III, and IV are offered in the following paragraphs.

Presentation

Normal acceleration data are presented in 0.1g intervals (above preselected threshold values) in tables II and IV for incremental gust and maneuver accelerations, respectively, and in intervals of 4 ft/sec in table III for derived gust velocities. The derived gust velocities were calculated from gust accelerations and their associated airspeeds using the equation $U_{de} = \frac{2Wa_n}{K_g \rho_o V_e m S}$. In each table, the

type of operation is identified and the airplanes involved in the operation are listed from left to right by order of decreasing gross weight. Airplane types 4, 9, 12, and 17 were involved in more than one type of operation. Significant information relative to each airplane data sample is given at the bottom of each table.

Thresholds

Early on in the program, acceleration reading thresholds for airplanes in the general aviation category were ±0.2g, a carry-over from thresholds used in the evaluation of VGH records from the normally larger and heavier transport airplanes. This threshold value resulted in a prohibitively large number of man-hours spent reading relatively insignificant acceleration inputs. Calculations of critical values of acceleration from a repeated-loads standpoint and discussions with major general aviation manufacturers indicated a threshold of ±0.4g would be sufficient. Data from most airplane types were read to a threshold of ±0.4g; however, because of their heavier weight and higher wing loadings airplane types 1 and 19 to 24 were read to a threshold of ±0.2g or ±0.3g. Airplane type 28, one of the first airplanes in the program, and one of the lightest, was read to a threshold of ±0.2g. Acceleration values below 0.4g for airplane 28 illustrate the large percentage of the total acceleration count found in these intervals.

Many of the airplanes show a larger number of derived gust velocities in the ±12- to ±16-ft/sec interval than in either the ±4- to ±8- or the ±8- to ±12-ft/sec interval. This abnormality is caused by the cut-off of accelerations less than the reading threshold. These lower value accelerations contribute a large portion of the derived gust velocities in the ±0- to ±12-ft/sec interval.

Data Precision

Although the accuracy of the NASA VGH flight recorder has been established over the years (refs. 2 and 6, e.g.) a comment relative to the reading accuracy of the general aviation airplane records is in order.

The reliability of the data is affected by instrument error, installation error, and reading error. Total overall errors for the VGH recorder are discussed in section I of reference 6 and are estimated to be:

Parameter	Error
Acceleration, g units	±0.05
Indicated airspeed, knots	
100 knots	±6
350 knots	±2
Pressure altitude, ft	
2000 ft	±300
20 000 ft	±500

Reading errors are believed to be small in terms of the magnitudes of the particular quantities read, inasmuch as each tabulation has been checked and corrected for gross errors. The reading errors for acceleration, although small, may affect

the count of accelerations exceeding given values. Reading checks have indicated that for individual records, the number of acceleration counts may have a reliability of about ±30 percent, except for the extreme values, which were individually verified by detailed review of the time histories. Therefore, it is believed that the reliability of the frequency of occurrence of the extreme values is much better than ±30 percent. Since reading errors tend to balance out as the sample size increases, the values of cumulative frequency per mile for the overall distributions of gust and maneuver accelerations and of derived gust velocities are estimated to be within ±20 percent. The statistical reliability of the results presented in this paper may be increased by combining data samples from the same type airplanes used in the same type of operations to achieve a larger data sample. Individual airplane samples were intentionally presented to allow comparisons of individual operations.

CONCLUDING REMARKS

Tables of incremental gust and maneuver acceleration counts in 0.1g intervals (above preselected threshold values) and derived gust velocities in intervals of 4 ft/sec are presented for 95 general aviation airplanes flown in 9 types of operations. These data represent all the acceleration data that have been evaluated from the NASA VGH General Aviation Program.

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April 28, 1983

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   Part 3 - Normal, Utility, Aerobatic, and Restricted Purpose Categories, Nov. 1, 1949.
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TABLE I.- CHARACTERISTICS OF INSTRUMENTED AIRPLANES

Airplane data	Twin-engine executive operations for airplane type -					
	1	2	2A	3	4	5
Maximum gross weight, lb	26 455	13 000	12 500	9 000	4 830	4 800
Wing span, ft	53.5	35.8	35.8	45.9	36.0	37.0
Wing area, ft^2	441	231.8	231.8	279.7	175.0	207.0
Type propulsion	Turbojet	Turbojet	Turbojet	Turboprop	Piston	Piston
Power per engine, hp				500	260	250
Thrust per engine, lb	4200	2850	2850			
V_C at sea level, knots	388	350	350	208	182	172
V_D at sea level, knots	485	400	400	260	239	240
n_m at V_C	2.50	4.40	4.40	3.40	3.80	3.80
$-n_m$ at V_C	1.00	1.76	1.76	1.68	1.52	1.52
n_g at V_C	4.40	3.44	3.44	3.10	2.97	3.10
$-n_g$ at V_C	2.40	1.44	1.44	1.10	0.97	1.10

Airplane data	Single-engine executive operations for airplane type -								
	6	7	7A	7B	7C	8	8A	9	9A
Maximum gross weight, lb	4000	3400	3300	3125	2650	3200	2900	2650	2550
Wing span, ft	36.8	33.5	33.5	33.5	32.8	36.0	36.0	36.0	36.0
Wing area, ft^2	175.0	181.0	181.0	181.0	177.6	178.0	178.0	174.0	174.0
Type propulsion	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston
Power per engine, hp	310	285	285	260	185	260	250	230	225
Thrust per engine, lb									
V_C at sea level, knots	165	165	165	161	139	156	156	139	139
V_D at sea level, knots	220	217	217	217	217	219	219	180	177
n_m at V_C	3.80	4.40	4.40	4.40	4.40	3.80	3.80	3.80	3.80
$-n_m$ at V_C	1.52	1.76	1.76	1.76	1.76	1.52	1.52	1.52	1.52
n_g at V_C	3.30	3.37	3.35	3.43	3.40	3.48	3.65	3.33	3.50
$-n_g$ at V_C	1.30	1.37	1.35	1.43	1.40	1.48	1.65	1.33	1.50

TABLE I.- Continued

Airplane data	Personal operations for airplane type -					
	10	10A	11	12	12A	13
Maximum gross weight, lb . . .	2740	2575	2475	2400	2200	2250
Wing span, ft	35.0	35.0	35.0	30.0	30.0	36.0
Wing area, ft^2	167.0	167.0	180.0	160.0	160.0	174.0
Type propulsion	Piston	Piston	Piston	Piston	Piston	Piston
Power per engine, hp	200	180	180	180	160	145
Thrust per engine, lb . . .						
V_C at sea level, knots . . .	152	130	122	122	122	122
V_D at sea level, knots . . .	194	182	170	165	165	165
n_m at V_C	3.80	3.80	3.80	3.80	3.80	3.80
$-n_m$ at V_C	1.52	1.52	1.52	1.52	1.52	1.52
n_g at V_C	3.37	3.42	*3.41	3.30	3.30	3.39
$-n_g$ at V_C	1.37	1.42	*1.41	1.30	1.30	1.39

Airplane data	Instructional operations for airplane type -							
	4A	14	14A	15	12B	16	17	19
Maximum gross weight, lb . . .	5300	2450	2200	2250	2150	1650	1500	1500
Wing span, ft	37.0	32.8	32.8	35.0	30.0	30.0	33.4	35.2
Wing area, ft^2	179.0	146.0	146.0	180.0	160.0	147.0	160.0	170.0
Type propulsion	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston
Power per engine, hp	260	180	150	150	140	108	100	95
Thrust per engine, lb . . .								
V_C at sea level, knots . . .	182	128	128	117	122	96	104	87
V_D at sea level, knots . . .	248	180	180	164	165	143	152	130
n_m at V_C	3.80	4.40	4.40	3.60	3.80	4.40	4.40	4.52
$-n_m$ at V_C	1.52	1.90	1.90	1.52	1.52	1.76	1.76	1.20
n_g at V_C	2.84	*3.58	*3.80	*3.46	3.30	3.00	3.46	3.38
$-n_g$ at V_C	0.84	*1.58	*1.80	*1.46	1.30	1.00	1.46	1.38

*Calculated.

TABLE I.- Continued

Airplane data	Commercial survey operations for airplane type -													
	19	20	21	22	23	24	25	4	26	6A	27	9B	17[1]	28
Maximum gross weight, lb	126 000	106 000	80 000	64 000	31 000	26 300	5400	4830	4300	3800	2950	2800	1500	1500
Wing span, ft	117.5	117.5	98.0	109.3	95.0	69.7	37.8	36.0	38.0	36.8	32.8	36.2	33.4	35.2
Wing area, ft^2	1463	1457	1000	1447	987.0	485.0	199.2	175.0	201.0	175.0	177.6	174.0	160.0	178.5
Type propulsion	Piston	Piston	Piston, turbojet	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston
Power per engine, hp	3250	2400	3500	3250	1475	1525	285	260	210	285	225	230	100	95
Thrust per engine, lb			3400											
V_C at sea level, knots	269	260	175	†NA	163	130	195	182	165	165	152	139	104	95
V_D at sea level, knots	346	346	360	†NA	209	373	247	239	215	217	243	186	152	143
n_m at V_C	2.50	2.50	3.00	3.00	2.50	3.00	4.20	3.80	3.80	3.80	6.00	3.80	4.40	4.40
$-n_m$ at V_C	1.00	1.00	1.00	1.00	1.00	1.00	3.00	1.52	1.52	1.52	3.00	1.52	1.76	1.76
n_g at V_C	*2.42	*2.79	*2.31	*2.81	*3.74	*3.16	3.20	2.97	3.16	3.41	3.26	3.33	3.46	3.59
$-n_g$ at V_C	*0.42	*0.79	*0.31	*0.81	*1.74	*1.16	1.20	0.97	1.16	1.41	1.26	1.33	1.46	1.59

*Calculated.
†Not available.

Airplane data	Aerial application operations for airplane type -											
	29	30	30A	31	32	33	33A	34	35	36	36A	37
Maximum gross weight, lb	†8200	†6900	6000	†6900	†6075	†6075	†6000	†4400	†4200	†4000	†3800	2900
Wing span, ft	44.4	44.4	42.6	45.1	Upper 35.7	Upper 35.7	Upper 35.7	38.8	41.1	40.7	40.4	36.2
Wing area, ft^2	326.6	326.6	312.4	270.6	328	326	326	225	208.7	202	202	183
Type propulsion	Turboprop	Piston	Piston	Piston	Turboprop	Piston	Piston	Piston	Piston	Piston	Piston	Piston
Power per engine, hp	750	600	650	600	750	650	600	285	300	300	230	235
Thrust per engine, lb												
V_C at sea level, knots	117	117	109	113	128	128	128	130	125	125	125	108
V_D at sea level, knots	164	164	153	170	142	142	142	175	175	175	175	151
n_m at V_C	3.80	3.80	3.80	3.80	4.20	4.20	4.20	3.80	3.80	3.80	3.80	3.80
$-n_m$ at V_C	1.52	1.90	1.90	1.90	1.00	1.00	1.00	1.52	1.52	1.52	1.52	1.52
n_g at V_C	*3.07	*2.78	*2.78	2.51	*2.60	*2.62	*2.62	3.25	3.31	3.31	3.31	2.83
$-n_g$ at V_C	*1.07	*0.78	*0.78	0.51	*0.60	*0.62	*0.62	1.25	1.31	1.31	1.31	0.83

*Calculated.
†Restricted category.

TABLE I.- Concluded

Airplane data	Aerobatic operations for airplane type -	Commuter operations for airplane type -		Float operations for airplane type -
	38	39	40	41
Maximum gross weight, lb . . .	1650	11 600	10 400	5090
Wing span, ft	33.4	65.0	45.9	48.0
Wing area, ft^2	165.0	420	279.7	250
Type propulsion	Piston	Turboprop	Turboprop	Piston
Power per engine, hp	115	550	550	450
Thrust per engine, lb . . .				
V_C at sea level, knots . . .	104	160	226	126
V_D at sea level, knots . . .	156	225	282	152
n_m at V_C	*4.79	3.21	3.29	*3.69
$-n_m$ at V_C	*2.29	1.50	1.32	*1.48
n_g at V_C	*3.58	3.35	2.95	*2.79
$-n_g$ at V_C	*1.95	1.35	0.95	0.79

*Calculated.

TABLE II.- GUST ACCELERATION DISTRIBUTION

Incremental normal acceleration, g units	Frequency of occurrence for airplane type -																				
	Twin-engine executive operations											Single-engine executive operations									
	1	*1[1]	*1[2]	*1[3]	2	2A	*3	3[1]	4	5	5[1]	6	7	7A	7B	7C	7C[1]	8	8A	8A[1]	9	9A
-2.7 to -2.8																						
-2.6 to -2.7																						
-2.5 to -2.6																						
-2.4 to -2.5																						
-2.3 to -2.4																						
-2.2 to -2.3																						
-2.1 to -2.2																						
-2.0 to -2.1																						
-1.9 to -2.0																						
-1.8 to -1.9																		1	1			
-1.7 to -1.8										1								0	0			1
-1.6 to -1.7										0			1					0	0			0
-1.5 to -1.6									1	0	1		0					0	0			3
-1.4 to -1.5									1	4	0		6					2	0			2
-1.3 to -1.4					1		1	1	0	4	1	1	10				1	6	0			3
-1.2 to -1.3	2				0		0	1	4	5	2	1	24				1	14	0		1	5
-1.1 to -1.2	0				0	1	2	7	5	18	4	3	54			6	14	4	1	1	8	
-1.0 to -1.1	2				3	4	2	10	14	15	10	3	143		5	2	7	23	1	3	4	23
-0.9 to -1.0	4	1			6	4	9	29	25	40	20	8	318		12	3	19	76	14	9	23	64
-0.8 to -0.9	2	1			9	18	8	65	92	122	32	28	724	1	28	12	41	211	33	43	55	155
-0.7 to -0.8	5	4			27	53	26	152	288	296	134	75	1 635	5	112	32	102	506	85	111	164	373
-0.6 to -0.7	24	7	1	2	109	223	98	457	878	751	365	188	3 827	12	452	104	280	1 455	390	367	504	1125
-0.5 to -0.6	73	28	9	8	441	669	363	1 221	2 674	2 078	943	503	6 703	79	1 346	437	733	3 822	1 345	1 007	1 448	3 458
-0.4 to -0.5	207	114	30	38																		
-0.3 to -0.4	596	622	255	268																		
-0.2 to -0.3	1 287	2 517	1 147	582																		
Negative total	2 202	3 294	1 442	898	596	972	509	1 943	3 982	3 334	1 512	810	13 445	97	1 955	590	1 192	6 130	1 873	1 541	2 200	5 220
0.2 to 0.3	1 717	3 144	1 248	555																		
0.3 to 0.4	672	666	190	254																		
0.4 to 0.5	223	129	31	42	600	702	436	1 321	3 168	1 915	1 281	496	7 998	150	2 139	658	891	4 206	1 463	1 233	1 816	4 252
0.5 to 0.6	78	31	5	10	134	208	89	478	1 050	773	447	172	4 643	32	1 070	188	324	1 907	361	486	629	1 580
0.6 to 0.7	32	13	2	1	31	54	22	171	383	338	132	69	2 088	3	333	64	132	700	81	133	206	508
0.7 to 0.8	16	7			12	35	6	71	127	128	44	30	929	4	113	18	39	270	20	42	69	227
0.8 to 0.9	8	2			8	11	5	18	44	57	15	12	421	1	34	3	19	109	5	17	28	80
0.9 to 1.0	2				4	4	3	7	17	23	8	5	177	0	15	3	10	41	7	3	13	27
1.0 to 1.1	4				1	1	2	7	3	8	7	1	100	0	5	2	2	27	2	2	5	6
1.1 to 1.2					0	0	0	2	1	4	2		40	2	1		1	17	3	1	1	6
1.2 to 1.3					1	0	1	1	3	4	0		22				2	11	1		1	4
1.3 to 1.4						0		2	1	1	0		12					1			0	1
1.4 to 1.5						0			1	1	0		6					1			2	0
1.5 to 1.6						0			2		0		1					1			1	1
1.6 to 1.7						1			1		1							0				
1.7 to 1.8													1					0				
1.8 to 1.9													1					1				
1.9 to 2.0																		0				
2.0 to 2.1																		1				
2.1 to 2.2																						
2.2 to 2.3																						
2.3 to 2.4																						
2.4 to 2.5																						
2.5 to 2.6																						
2.6 to 2.7																						
2.7 to 2.8																						
2.8 to 2.9																						
2.9 to 3.0																						
3.0 to 3.1																						
3.1 to 3.2																						
3.2 to 3.3																						
3.3 to 3.4																						
Positive total	2 752	3 992	1 476	862	791	1 011	564	2 078	4 801	3 252	1 937	785	16 439	192	3 710	936	1 420	7 293	1 943	1 917	2 771	6 692
Positive and negative total	4 954	7 286	2 918	1 760	1 387	1 983	1 073	4 021	8 783	6 586	3 449	1 595	29 884	289	5 665	1 526	2 612	13 423	3 816	3 458	4 971	11 912
Number of flights	464	663	232	25	904	721	202	1 290	1 672	614	202	106	403	34	157	164	317	287	137	150	294	500
Flight hours	578	760	244	41	1 335	597	213	1 427	1 254	563	263	268	402	15	229	150	164	253	162	147	301	423
Nautical miles	219 656	250 447	88 624	15 338	493 292	216 991	19 856	281 300	206 478	86 977	41 586	43 975	62 631	2241	34 419	18 351	19 182	38 678	21 481	20 540	37 137	55 059
Average pressure altitude, ft	24 533	19 887	21 982	27 100	29 905	23 215	11 143	9 914	4 444	4 695	7 411	13 085	7 520	4763	8 047	4 555	3 722	7 346	8 348	5 000	4 539	7 396
Average V, knots	380	329	363	372	369	363	187	197	165	154	158	164	165	145	150	122	117	153	133	140	123	130
Base, home state	FL	NY	NY	NY	IA	OH	KS	VA	WI	VA	CA	NY	MT	VA	NM	DC	NY	ID	MT	TX	IN	ID

*Airplane used as flight demonstrator.

TABLE II.- Continued

Incremental normal acceleration, g units	Frequency of occurrence for airplane type -																				
	Personal operations											Instructional operations									
	10	10A	10A[1]	11	12	12[1]	12[2]	12[3]	12A	13	13[1]	4A	14	14A	15	12B	12B[1]	12B[2]	16	17	18	18[1]
-2.7 to -2.8																					
-2.6 to -2.7																					
-2.5 to -2.6																					
-2.4 to -2.5																					
-2.3 to -2.4																					
-2.2 to -2.3																					
-2.1 to -2.2																					
-2.0 to -2.1																					
-1.9 to -2.0																				1	
-1.8 to -1.9																				1	
-1.7 to -1.8																				0	
-1.6 to -1.7																				1	
-1.5 to -1.6																				3	
-1.4 to -1.5																		1		2	
-1.3 to -1.4						1					1							1		1	
-1.2 to -1.3			1			0				2	0							1		0	
-1.1 to -1.2	1		1			1		1		2	0	1			1			3		4	
-1.0 to -1.1	2		1			0		3		9	1	0	1	3	0			2		5	
-0.9 to -1.0	12		1	3		0		2	1	15	1	3	7	6	1	5	1	17	2	9	2
-0.8 to -0.9	15	12	6	5		3	1	13	1	33	3	7	14	23	1	13	5	39	2	22	3	5
-0.7 to -0.8	53	10	20	18		5	4	41	3	89	21	21	44	54	9	17	18	131	7	82	9	15
-0.6 to -0.7	177	59	57	46	6	21	9	98	14	330	53	59	124	192	24	69	38	384	37	206	25	39
-0.5 to -0.6	425	174	167	121	17	87	30	490	58	894	207	188	408	785	99	247	157	1 326	225	722	59	222
-0.4 to -0.5	1 480	443	625	253	71	310	159	1 615	125	2 440	541	433	1 002	2 533	340	652	525	3 557	1 183	2 029	263	1 192
-0.3 to -0.4																					
-0.2 to -0.3																					
Negative total	2 165	698	879	446	94	428	203	2 263	202	3 814	828	712	1 600	3 596	475	1 003	744	5 462	1 456	3 088	361	1 473
0.4 to 0.5	1 555	427	939	284	66	316	277	1 204	152	2 657	653	652	1 219	2 681	323	784	437	3 378	1 456	2 531	152	1 694
0.5 to 0.6	488	173	292	70	14	77	33	233	41	884	175	202	333	833	103	269	135	974	236	740	50	347
0.6 to 0.7	172	48	91	29	3	16	3	61	14	233	66	56	135	231	22	93	40	286	60	194	23	52
0.7 to 0.8	83	23	34	11	1	6	4	13	1	75	10	15	47	72	9	27	20	92	16	68	11	20
0.8 to 0.9	19	8	17	3	0	4		6	1	13	5	10	15	27	2	8	5	37	4	28	5	4
0.9 to 1.0	12	2	7	1	1	2		2	0	6	1	5	10	14		3	2	18	1	15	3	6
1.0 to 1.1	3	1				1			1	2	2	1		13		1	1	9	1	1	1	1
1.1 to 1.2	4	0								1	2			1			2	2		4		
1.2 to 1.3	1	1								0	0			1				1		0		
1.3 to 1.4		1								0	0			2				0		2		
1.4 to 1.5										1	1							0		0		
1.5 to 1.6																		1		1		
1.6 to 1.7																				0		
1.7 to 1.8																				0		
1.8 to 1.9																				0		
1.9 to 2.0																				0		
2.0 to 2.1																				0		
2.1 to 2.2																				2		
2.2 to 2.3																				0		
2.3 to 2.4																				0		
2.4 to 2.5																				0		
2.5 to 2.6																				0		
2.6 to 2.7																				0		
2.7 to 2.8																				0		
2.8 to 2.9																				0		
2.9 to 3.0																				0		
3.0 to 3.1																				0		
3.1 to 3.2																				0		
3.2 to 3.3																				0		
3.3 to 3.4																				1		
Positive total	2 337	684	1 380	398	85	422	317	1 519	210	3 872	915	941	1 759	3 875	459	1 185	642	4 798	1 774	3 587	245	2 124
Positive and negative total	4 502	1 382	2 259	844	179	850	520	3 782	412	7 686	1 743	1 653	3 359	7 471	934	2 188	1 386	10 260	3 230	6 675	606	3 597
Number of flights	155	195	264	317	47	373	127	286	53	931	140	627	472	1 433	525	524	508	1 052	748	1 057	190	2 916
Flight hours	225	175	265	131	30	199	81	193	34	782	123	342	282	935	219	311	448	754	494	813	96	911
Nautical miles	31 563	22 436	34 231	12 596	3101	16 836	8222	19 192	3141	75 331	11 290	46 214	23 994	80 902	19 057	25 703	40 524	64 872	37 420	65 991	6962	68 764
Average pressure altitude, ft	6 122	3 513	5 736	4 116	2216	1 174	2413	2 792	1438	3 004	6 755	2 009	1 704	2 380	2 720	2 500	2 387	2 172	1 506	6 905	1999	2 030
Average V, knots	141	128	129	96	103	85	101	100	92	96	92	135	85	87	87	83	90	86	76	81	73	75
Base, home state	TX	VA	CA	CA	FL	FL	FL	SC	FL	SC	UT	FL	IL	OH	TX	NB	IN	IL	SC	CO	CA	CA

TABLE II.- Continued

Incremental normal acceleration, g units	Frequency of occurrence for airplane type - Commercial survey operations																			
	19	19[1]	20	20[1]	21	22	23	24	24[1]	24[2]	24[3]	24[4]	24[5]	25	4[1]	26	6A	27	9B	17[1]	28
-2.7 to -2.8														1							
-2.6 to -2.7														0							
-2.5 to -2.6														0							
-2.4 to -2.5														0							
-2.3 to -2.4														0			1				
-2.2 to -2.3				1										0			0				
-2.1 to -2.2														1			0			4	
-2.0 to -2.1														1			0			0	
-1.9 to -2.0														0			0			0	
-1.8 to -1.9														0			2	1		0	
-1.7 to -1.8														3			1	1		1	
-1.6 to -1.7														2			2	1		4	
-1.5 to -1.6														1			5	1		5	
-1.4 to -1.5														6			2	4	1	14	
-1.3 to -1.4														12			8	8	2	35	
-1.2 to -1.3					1		1							21			24	6	6	66	1
-1.1 to -1.2			1		0		2							26			66	25	14	173	0
-1.0 to -1.1			1	2	0		1							57	1	3	121	30	42	505	0
-0.9 to -1.0			2	6	1		1						2	119	2	17	256	64	67	1 227	3
-0.8 to -0.9			10	35	0		4	1			1		1	276	11	45	559	171	153	3 265	1
-0.7 to -0.8			12	228	5		12	2		1	2	2	6	544	16	164	1 462	321	414	8 260	3
-0.6 to -0.7	1		22	922	6	2	34	3		0	1	9	46	1 185	45	653	3 760	788	1 125	37 871	10
-0.5 to -0.6	2		100	1 610	27	4	131	19	7	7	11	23	109	2 602	123	2 317	8 432	1 731	3 303	37 871	21
-0.4 to -0.5	9	2	318	2 564	52	17	431	105	34	32	36	44	99	5 173	271	8 845	14 790	4 025	8 579	51 818	78
-0.3 to -0.4	41	2	661	2 391	122	21	649	244	111	266	71	108	69								630
-0.2 to -0.3					386																3
Negative total	53	4	1 127	7 758	600	44	1 266	374	152	306	122	186	332	10 030	469	12 044	29 491	7 177	13 706	120 654	750
0.2 to 0.3					473																0
0.3 to 0.4	61	5	996	677	142	25	877	349	213	343	50	181	122								723
0.4 to 0.5	20	10	540	308	52	17	687	144	45	27	23	142	41	6 494	334	14 373	17 713	4 892	8 522	64 397	131
0.5 to 0.6	2	2	143	113	37	3	214	23	11	6	7	65	9	3 023	170	4 454	8 842	1 947	2 471	42 424	41
0.6 to 0.7	1		48	36	18	3	66	3	5	2	6	28	4	1 310	40	1 289	3 560	907	795	15 930	16
0.7 to 0.8			24	19	9	1	20	2	2	1	3	13		656	19	364	1 330	434	251	4 659	2
0.8 to 0.9			7	7	4	1	5	1	1	1		4		278	10	88	571	238	90	1 051	1
0.9 to 1.0			6		5		2					2		150		29	243	124	54	279	1
1.0 to 1.1			0		0		1							85		10	101	68	17	63	1
1.1 to 1.2			1		1									47		5	55	38	9	28	
1.2 to 1.3			3		0									18		0	31	31	5	5	
1.3 to 1.4					0									13		0	13	13	6	5	
1.4 to 1.5					0									5		1	4	10	2	2	
1.5 to 1.6					0									7			4	3	0	0	
1.6 to 1.7					0									6			1	5	3	0	
1.7 to 1.8					0									1				2	1	0	
1.8 to 1.9					1									0				4		0	
1.9 to 2.0					0									0				2		0	
2.0 to 2.1					0									0						0	
2.1 to 2.2					0									0						0	
2.2 to 2.3					0									0						1	
2.3 to 2.4					1									1							
2.4 to 2.5														0							
2.5 to 2.6														0							
2.6 to 2.7														1							
2.7 to 2.8																					
2.8 to 2.9																					
2.9 to 3.0																					
3.0 to 3.1																					
3.1 to 3.2																					
3.2 to 3.3																					
3.3 to 3.4																					
Positive total	84	17	1 768	1 160	743	50	1 872	522	277	380	89	435	176	12 095	573	20 613	32 468	8 718	12 226	128 844	916
Positive and negative total	137	21	2 895	8 918	1 343	94	3 138	896	429	686	211	621	508	22 125	1 042	32 657	61 959	15 895	25 932	249 498	1 666
Number of flights	28	28	343	391	304	61	196	248	168	126	120	171	155	169	67	612	277	195	316	492	211
Flight hours	24	24	285	328	305	29	222	78	92	67	67	101	86	246	79	901	545	253	740	1 258	888
Nautical miles	4209	4245	50 316	58 213	53 440	4052	31 242	11 969	13 597	10 222	10 300	16 205	13 302	37 921	12 339	126 142	82 899	31 187	82 334	111 407	54 312
Average pressure altitude, ft	4952	5165	5 015	5 368	5 262	2960	8 162	2 907	2 922	2 835	3 355	2 855	1 954	7 478	6 908	2 870	6 080	5 059	6 895	1 150	1 706
Average V, knots	178	180	176	178	175	141	141	153	147	152	153	161	144	154	156	140	152	123	111	89	61
Base, home state	OR	AZ	OR	OR	OR	CA	ID	CA	CA	CA	CA	CA	CA	NM	ID	NE	WY	OR	OR	OK	VA

TABLE II.- Continued

Incremental normal acceleration, g units	Frequency of occurrence for airplane type - Aerial application operations																									
	29	29[1]	30	30[1]	30[2]	30A	31	32	32[1]	32[2]	33	33[1]	33A	33A[1]	33A[2]	34	34[1]	34[2]	34[3]	35	35[1]	35[2]	36	36A	37	37[1]
-2.7 to -2.8																										
-2.6 to -2.7																										
-2.5 to -2.6																										
-2.4 to -2.5																										
-2.3 to -2.4																										
-2.2 to -2.3																										
-2.1 to -2.2																										
-2.0 to -2.1																										
-1.9 to -2.0																										
-1.8 to -1.9																										
-1.7 to -1.8																	1									
-1.6 to -1.7																	6									
-1.5 to -1.6																	0									
-1.4 to -1.5																	0									
-1.3 to -1.4																	0									
-1.2 to -1.3																	1				1					
-1.1 to -1.2																	0				0		2			
-1.0 to -1.1																	0	1	1	1	0		2			
-0.9 to -1.0	1					3											2	0	2	1	4		6			2
-0.8 to -0.9	1	6				0					1						0	1	8	3	6	3	24			2
-0.7 to -0.8	10	22	1			2	1				3	2			2	1	7	3	23	13	24	4	63		1	5
-0.6 to -0.7	36	43	2		1	5	0	5		2	14	4			3	1	18	14	67	29	94	18	239		4	12
-0.5 to -0.6	90	82	4	9	5	31	0	13		15	110	19	1		7	4	66	75	243	84	116	37	522	1	19	65
-0.4 to -0.5	101	74	20	4	35	59	0	58		25	373	86	2	1	43	4	110	237	678	132	252	61	577	8	132	160
-0.3 to -0.4																										
-0.2 to -0.3																										
Negative total	239	227	27	13	41	100	1	76	0	42	501	111	3	1	55	10	205	331	1 022	263	497	123	1 435	9	156	246
0.2 to 0.3																										
0.3 to 0.4																										
0.4 to 0.5	338	155	42	23	57	111		72		15	638	79	11	4	58	7	213	451	1 222	134	293	65	1 236	26	152	232
0.5 to 0.6	285	231	20	15	9	17		13		6	319	16		3	15	9	70	92	233	59	137	38	566	6	29	75
0.6 to 0.7	201	190	20	3	0	4		3		1	134	5			3	1	17	26	54	18	112	7	155	2	4	23
0.7 to 0.8	93	110	6		0	1		2		1	51	3				0	8	8	8	2	47	8	37		1	7
0.8 to 0.9	32	46	1		0			0		0	14	1				1	5	1	3	0	11	1	19			3
0.9 to 1.0	17	25	1		1			1		0	8						2	1	1	1	6		9			
1.0 to 1.1	1									1	2						0		1	0	0		1			
1.1 to 1.2	2										1						0			0	0					
1.2 to 1.3	2																0			0	0					
1.3 to 1.4	0																0			1	0					
1.4 to 1.5	0																0				1					
1.5 to 1.6	1																0									
1.6 to 1.7																	0									
1.7 to 1.8																	1									
1.8 to 1.9																										
1.9 to 2.0																										
2.0 to 2.1																										
2.1 to 2.2																										
2.2 to 2.3																										
2.3 to 2.4																										
2.4 to 2.5																										
2.5 to 2.6																										
2.6 to 2.7																										
2.7 to 2.8																										
2.8 to 2.9																										
2.9 to 3.0																										
3.0 to 3.1																										
3.1 to 3.2																										
3.2 to 3.3																										
3.3 to 3.4																										
Positive total	972	757	90	41	67	133	0	91	0	24	1 167	104	11	7	76	18	314	579	1 522	215	607	119	2 023	34	186	340
Positive and negative total	1 211	984	117	54	108	233	1	167	0	66	1 668	215	14	8	131	28	521	910	2 544	478	1 104	242	3 458	43	342	586
Number of flights	1 164	424	605	58	546	2 873	507	760	221	1 446	594	467	247	230	107	156	337	347	731	1 311	652	342	1 195	180	829	488
Flight hours	339	298	127	47	140	782	174	100	54	198	351	124	45	23	13	31	203	187	322	357	392	137	208	72	175	342
Nautical miles	39 219	30 818	11 838	4437	12 459	67 855	16 831	9017	5234	17 527	29 909	10 689	3438	1815	1114	2888	18 166	15 642	29 184	33 591	39 317	13 952	18 838	6071	14 032	24 905
Average pressure altitude, ft	165	193	840	2369	664	1 148	7 993	87	953	536	492	11	148	83	144	2377	1 295	658	193	4 982	1 351	3 770	97	929	170	2 691
Average V, knots	116	104	93	95	89	87	97	90	97	89	85	87	77	80	87	93	90	84	91	94	100	102	91	85	80	73
Base, home state	AL	TX	OR	NE	OR	AZ	AZ	TX	MI	TX	VA	TX	CA	TX	CA	AZ	TX	FL	FL	MT	TX	TX	TX	AZ	FL	TX

TABLE II.- Concluded

Incremental normal acceleration, g units	Frequency of occurrence for airplane type -			
	Aerobatic operations	Commuter operations		Float operations
	38	39	40	41
-1.7 to -1.8			2	
-1.6 to -1.7			3	
-1.5 to -1.6			0	
-1.4 to -1.5			6	
-1.3 to -1.4			1	
-1.2 to -1.3		2	15	1
-1.1 to -1.2		6	12	3
-1.0 to -1.1	1	5	45	3
-0.9 to -1.0	5	17	89	8
-0.8 to -0.9	7	49	177	10
-0.7 to -0.8	36	106	517	40
-0.6 to -0.7	81	337	1 348	99
-0.5 to -0.6	272	1 003	3 609	256
-0.4 to -0.5	384	3 113	8 325	570
Negative total	786	4 638	14 149	990
0.4 to 0.5	513	3 499	9 626	442
0.5 to 0.6	193	1 123	3 454	173
0.6 to 0.7	60	419	1 145	74
0.7 to 0.8	25	184	393	33
0.8 to 0.9	8	59	130	14
0.9 to 1.0	3	18	65	4
1.0 to 1.1	0	2	29	1
1.1 to 1.2	1	9	10	2
1.2 to 1.3		3	7	
1.3 to 1.4		0	3	
1.4 to 1.5		3	1	
1.5 to 1.6		0	0	
1.6 to 1.7		2	1	
Positive total	803	5 321	14 874	743
Positive and negative total	1 589	9 959	29 023	1 733
Number of flights	335	7 378	5 143	1 623
Flight hours	170	2 056	2 684	885
Nautical miles	13 723	274 012	508 180	89 722
Average pressure altitude, ft	1 659	2 324	4 278	2 505
Average V, knots	81	133	189	101
Base, home state	VA	CA	PA	WA

TABLE III.- GUST VELOCITY DISTRIBUTION

Derived gust velocity U_{de}, ft/sec	Frequency of occurrence for airplane type -																				
	Twin-engine executive operations											Single-engine executive operations									
	1	*1[1]	*1[2]	*1[3]	2	2A	*3	3[1]	4	5	5[1]	6	7	7A	7B	7C	7C[1]	8	8A	8A[1]	9	9A
-68 to -72																						
-64 to -68																						
-60 to -64																						
-56 to -60																						
-52 to -56																						
-48 to -52					1																	
-44 to -48					0																	
-40 to -44	1	1			0																	
-36 to -40	0	0			1					1												
-32 to -36	2	0			1					2												
-28 to -32	2	4		2	5	1	1	2	3	0							1		1			1
-24 to -28	6	7	2	2	15	7	2	7	5	4	2		2				2		0			3
-20 to -24	36	17	11	12	51	20	6	40	33	20	4	2	22			1	8	6	2		1	7
-16 to -20	95	108	48	28	131	84	28	119	142	86	30	15	124		8	10	48	26	9	3	16	34
-12 to -16	272	446	208	127	296	348	148	540	788	495	164	89	1 090	2	79	63	158	145	100	38	168	265
-8 to -12	802	1 336	548	363	95	481	319	1 211	2 892	2 183	1 035	544	6 975	35	880	381	667	1 729	979	533	1 218	2 320
-4 to -8	986	1 375	625	364		31	5	24	119	543	277	160	5 232	60	988	135	308	4 224	782	967	797	2 590
Negative total	2 202	3 294	1 442	898	596	972	509	1 943	3 982	3 334	1 512	810	13 445	97	1 955	590	1 192	6 130	1 873	1 541	2 200	5 220
4 to 8	1 336	1 718	632	313		36	3	20	126	416	352	176	6 295	104	1 598	260	430	4 774	1 013	1 183	1 184	3 569
8 to 12	946	1 607	562	396	161	488	390	1 250	3 411	2 221	1 350	497	8 522	73	1 911	576	804	2 271	851	678	1 369	2 794
12 to 16	326	498	233	125	390	349	149	636	1 026	487	188	92	1 355	11	185	91	155	191	69	52	176	295
16 to 20	106	126	44	16	137	97	15	138	194	100	32	17	215	4	15	8	26	37	9	4	32	29
20 to 24	22	37	4	11	52	33	5	20	26	21	12	2	41		1	1	5	15	1		6	4
24 to 28	11	3	1	1	28	5	1	11	11	5	2	0	6					4			3	1
28 to 32	2	3			16	1	1	3	4	2	1	0	0					0			1	
32 to 36	2				4	0			1			1	4					0				
36 to 40	1				0	1			2				1					1				
40 to 44					1	1																
44 to 48					2																	
48 to 52																						
52 to 56																						
56 to 60																						
60 to 64																						
64 to 68																						
68 to 72																						
72 to 76																						
76 to 80																						
80 to 84																						
84 to 88																						
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92 to 96																						
96 to 100																						
100 to 104																						
104 to 108																						
108 to 112																						
112 to 116																						
116 to 120																						
120 to 124																						
124 to 128																						
Positive total	2 752	3 992	1 476	862	791	1 011	564	2 078	4 801	3 252	1 937	785	16 437	132	3 710	936	1 420	7 293	1 943	1 917	2 771	6 692
Positive and negative total	4 954	7 286	2 918	1 760	1 387	1 983	1 073	4 021	8 783	6 586	3 449	1 595	29 884	289	5 665	1 526	2 612	13 423	3 816	3 458	4 971	11 912
Number of flights	464	663	232	25	904	721	202	1 290	1 672	614	202	106	403	34	157	164	317	287	137	150	294	500
Flight hours	578	760	244	41	1 335	597	213	1 427	1 254	563	263	268	402	15	229	150	164	253	162	147	301	423
Nautical miles	219 656	250 447	88 624	15 338	493 292	216 991	39 856	281 300	206 478	86 977	41 588	43 975	62 631	2241	34 419	18 351	19 182	38 678	21 481	20 540	37 137	55 059
Average pressure altitude, ft	24 533	19 887	21 982	27 100	29 905	23 215	11 143	9 914	4 444	4 695	7 411	13 085	7 520	4763	8 047	4 555	3 722	7 346	8 348	5 000	4 539	7 396
Average V, knots	380	329	363	372	369	363	187	197	165	154	158	164	356	145	150	122	117	153	133	140	123	130
Base, home state	FL	NY	NY	NY	IA	OH	KS	VA	WI	VA	CA	NY	MT	VA	NH	DC	NY	ID	MT	TX	IN	ID

*Airplane used as flight demonstrator.

TABLE III.- Continued

Derived gust velocity U_{de}, ft/sec	Frequency of occurrence for airplane type -																					
	Personal operations											Instructional operations										
	10	10A	10A[1]	11	12	12[1]	12[2]	12[3]	12A	13	13[1]	4A	14	14A	15	12B	12B[1]	12B[2]	16	17	18	18[1]
-68 to -72																						
-64 to -68																						
-60 to -64																						
-56 to -60																						
-52 to -56																						
-48 to -52																				3		
-44 to -48													1	1						0		
-40 to -44													1	0						7		
-36 to -40													0	2				1		9	1	
-32 to -36						1	1						3	1			1	1	1	17	4	
-28 to -32				1		1	0			2	1	4	3	3		3	3	16	3	20	1	1
-24 to -28			2	5		2	1	6	1	5	1	13	18	25	2	10	2	46	11	42	7	0
-20 to -24	2	8	6	20		12	4	47	4	28	9	65	98	118	13	46	26	231	21	54	10	7
-16 to -20	55	53	76	92	15	127	29	335	54	253	76	272	555	813	72	316	124	1 370	251	331	38	77
-12 to -16	636	304	423	264	75	285	159	1 769	143	2 163	572	356	915	2 607	339	623	564	3 694	1 167	2 152	214	1 019
-8 to -12	1 462	333	372	64	4	0	9	106	0	1 363	169	2	6	26	49	5	24	103	2	453	86	369
-4 to -8	2 165	698	879	446	94	428	203	2 263	202	3 814	828	712	1 600	3 596	475	1 003	744	5 462	1 456	3 088	361	1 473
Negative total	1 555	325	626	61	2	1	13	72	0	1 491	235	0	6	27	35	9	33	97	10	581	58	573
4 to 8	704	300	681	249	71	273	258	1 257	170	2 145	583	516	1 016	2 632	322	682	421	3 272	1 456	2 534	120	1 427
8 to 12	67	48	65	66	11	128	38	152	37	209	75	311	572	846	89	398	135	1 099	273	362	48	103
12 to 16	10	9	8	15	0	7	3	29	2	22	14	73	86	163	10	77	30	217	30	66	14	13
16 to 20	0	0		3	0	11	4	4	1	3	2	11	34	82	1	12	7	57	4	18	5	4
20 to 24	1	0		3	0	1	0	1		2	1	11	19	51	2	3	9	26	1	11		3
24 to 28		1		1	1	0	0	2			2	12	11	27		3	4	11		6		1
28 to 32		1				0	0	0			2	3	13	23		1	2	13		2		
32 to 36						1	1	1			0	1	0	10			1	3		2		
36 to 40								0			0	2	2	9				3		4		
40 to 44								1			1	1		3						0		
44 to 48														2						0		
48 to 52																				1		
52 to 56																						
56 to 60																						
60 to 64																						
64 to 68																						
68 to 72																						
72 to 76																						
76 to 80																						
80 to 84																						
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92 to 96																						
96 to 100																						
100 to 104																						
104 to 108																						
108 to 112																						
112 to 116																						
116 to 120																						
120 to 124																						
124 to 128																						
Positive total	2 337	684	1 380	398	85	422	317	1 519	210	3 872	915	941	1 759	3 875	459	1 185	642	4 798	1 774	3 587	245	2 124
Positive and negative total	4 502	1 382	2 259	844	179	850	520	3 782	412	7 686	1 743	1 653	3 359	7 471	934	2 188	1 386	10 260	3 230	6 675	606	3 597
Number of flights	155	195	264	317	47	373	127	286	53	931	140	627	472	1 433	525	524	508	1 052	748	1 057	190	2 916
Flight hours	255	175	265	131	30	199	81	193	34	782	123	342	282	935	219	311	448	754	494	813	96	911
Nautical miles	31 563	22 436	34 231	12 596	3101	16 836	8222	19 192	3141	75 331	11 290	46 214	23 994	80 902	19 057	25 703	40 524	64 872	37 420	65 991	6962	68 764
Average pressure altitude, ft	6 122	3 513	5 736	4 116	2216	1 174	2413	2 792	1438	3 004	6 755	2 009	1 704	2 380	2 720	2 500	2 387	2 172	1 506	6 905	1999	2 030
Average V, knots	141	128	129	96	103	85	101	100	92	96	92	135	85	87	87	83	90	86	76	81	73	75
Base, home state	TX	VA	CA	CA	FL	FL	FL	SC	FL	SC	UT	FL	IL	OH	TX	NB	IN	IL	SC	CO	CA	CA

TABLE III.- Continued

Derived gust velocity U_{de}, ft/sec	Frequency of occurrence for airplane type																			
	Commercial survey operations																			
	19	19[1]	20	20[1]	21	22	23	24	24[1]	24[2]	24[3]	24[4]	24[5]	25	4[1]	26	6A	27	9B	17[1]	28
-68 to -72					1									1							
-64 to -68					0									1							
-60 to -64					0									0							
-56 to -60					0									0							
-52 to -56				2	1									0							
-48 to -52			3	1	1									0			1				
-44 to -48			1	12	1									0			0				
-40 to -44			2	26	0		1							4			0				
-36 to -40			4	95	5		0						2	8			1	3			
-32 to -36	2	1	9	312	12	1	1		1				0	11			5	3		4	
-28 to -32	1	0	16	769	17	0	2	1	0		2		9	39			12	7	4	8	
-24 to -28	4	0	46	1 333	23	3	3	3	3	2	1	1	18	113	1		23	31	6	35	1
-20 to -24	23	0	121	1 860	58	6	16	5	6	3	3	11	86	287	9	7	156	64	50	255	1
-16 to -20	20	3	277	2 027	85	19	70	55	28	17	24	27	124	891	24	70	675	281	225	1 888	3
-12 to -16	3	0	514	1 205	227	15	356	218	83	113	60	75	81	2 709	114	1 013	4 324	1 209	1 633	14 632	19
-8 to -12			134	116	166		803	92	31	171	32	72	12	5 507	320	9 924	20 687	3 791	10 348	77 428	424
-4 to -8					3		14							459	1	1 030	3 607	1 788	1 440	26 404	302
Negative total	53	4	1 127	7 758	600	44	1 266	374	152	306	122	186	332	10 030	469	12 044	29 491	7 177	13 706	120 654	750
4 to 8					3		8	1						458	2	1 282	4 752	2 177	1 268	32 716	396
8 to 12			221	174	197		1 096	121	86	196	19	136	42	6 408	399	16 594	22 610	4 882	9 491	84 704	476
12 to 16	5	1	770	488	294	20	632	304	141	160	45	178	92	3 446	146	2 502	4 168	1 205	1 260	10 513	41
16 to 20	42	3	494	285	115	18	105	80	37	17	15	76	34	1 146	21	193	725	314	160	814	2
20 to 24	26	8	172	125	46	6	25	10	8	3	1	32	4	420	5	35	149	87	34	85	1
24 to 28	8	1	63	45	28	2	5	1	0	2	3	6	3	126		3	51	33	4	10	
28 to 32	2	2	21	22	25	1	0	1	2	1	3	2	0	55		1	9	16	5	1	
32 to 36	1	1	12	5	16	1	0	3	1	1	1	2	1	17		2	3	2	3	0	
36 to 40		1	8	9	6	1	1	0	1		0	1		13		0	1	1	0	1	
40 to 44			1	4	3	1		1	0		0	1		3		1		1	1		
44 to 48			3	2	4				0		1	1		1							
48 to 52			3	1	3				1		1			0							
52 to 56					0									0							
56 to 60					0									2							
60 to 64					0																
64 to 68					1																
68 to 72					0																
72 to 76					0																
76 to 80					0																
80 to 84					0																
84 to 88					0																
88 to 92					0																
92 to 96					0																
96 to 100					0																
100 to 104					0																
104 to 108					0																
108 to 112					1																
112 to 116					0																
116 to 120					0																
120 to 124					0																
124 to 128					1																
Positive total	84	17	1 768	1 160	743	50	1 872	522	277	380	89	436	176	12 095	573	20 613	32 468	8 718	12 226	128 844	916
Positive and negative total	137	21	2 895	8 918	1 343	94	3 138	896	429	686	211	621	508	22 125	1 042	32 657	61 959	15 895	25 932	249 498	1 666
Number of flights	28	28	343	391	304	61	196	248	168	126	120	171	155	169	67	612	277	195	316	492	211
Flight hours	24	24	285	328	305	29	222	78	92	67	67	101	86	246	79	901	545	253	740	1 258	888
Nautical miles	4209	4245	50 316	58 213	53 440	4052	31 242	11 969	13 597	10 222	10 300	16 205	12 302	37 921	12 339	126 142	82 899	31 187	82 334	111 407	54 312
Average pressure altitude, ft	4952	5165	5 015	5 368	5 262	2960	8 162	2 907	2 922	2 835	3 355	2 855	1 954	7 478	6 908	2 870	6 080	5 059	6 895	1 150	1 706
Average V, knots	178	180	176	178	175	141	141	153	147	152	153	161	144	154	156	140	152	123	111	89	61
Base, home state	OR	AZ	OR	OR	OR	CA	ID	CA	CA	CA	CA	CA	CA	NM	ID	NE	WY	OR	OR	OK	VA

TABLE III.- Continued

Derived gust velocity U_{de}, ft/sec	Frequency of occurrence for airplane type - Aerial application operations																									
	29	29[1]	30	30[1]	30[2]	30A	31	32	32[1]	32[2]	33	33[1]	33A	33A[1]	33A[2]	34	34[1]	34[2]	34[3]	35	35[1]	35[2]	36	36A	37	37[1]
-68 to -72																										
-64 to -68																										
-60 to -64																										
-56 to -60																										
-52 to -56																										
-48 to -52																	1									
-44 to -48																	0									
-40 to -44																	1									
-36 to -40						1											0									
-32 to -36						0					1															
-28 to -32			1			0	1	1			0						0	1			1		1			2
-24 to -28	1	10	0			4	0	0			9	1			2		2	3	1	1	1	3	6			3
-20 to -24	11	30	2		3	4	0	5		7	71	8	1		3	1	11	28	14	9	16	3	48		2	8
-16 to -20	55	78	10	11	14	28	0	19		15	264	38	2	1	14	3	45	93	65	25	68	26	253	1	9	56
-12 to -16	137	107	14	2	24	53	0	51		18	153	64	0	0	36	6	132	199	486	120	220	72	827	8	84	162
-8 to -12	35	2	0	0	0	10	0	0		2	3	0	0	0	0	0	13	7	456	108	191	19	298		61	15
-4 to -8																										
Negative total	239	227	27	13	41	100	1	76	0	42	501	111	3	1	55	10	205	331	1 022	263	497	123	1 435	9	156	246
8 to 8																										
8 to 12	147	7	1	0	0	23		0	0	0	10	0	0	0	0	0	24	6	891	106	220	25	669	11	50	28
12 to 16	463	230	12	20	47	86		54		13	293	54	4	1	48	2	219	368	565	94	254	63	1 050	19	126	222
16 to 20	263	303	23	17	12	19		23		7	516	37	7	2	23	12	50	155	57	12	108	23	219	4	9	70
20 to 24	69	151	19	4	3	4		5		1	224	8		3	4	1	14	40	7	0	18	6	61		1	17
24 to 28	19	52	14		0	0		4		1	82	4		1	1	2	5	8	1	1	4	2	11			3
28 to 32	4	11	11		3	1		2		1	24	1				1	2	1	0	1	2		5			
32 to 36	4	2	4		2			2		0	13						0	1	1	0	1		4			
36 to 40	2	1	4					1		1	4						0			0			1			
40 to 44	0		2								1						1			0			2			
44 to 48	1																1			1			1			
48 to 52																										
52 to 56																										
56 to 60																										
60 to 64																										
64 to 68																										
68 to 72																										
72 to 76																										
76 to 80																										
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92 to 96																										
96 to 100																										
100 to 104																										
104 to 108																										
108 to 112																										
112 to 116																										
116 to 120																										
120 to 124																										
124 to 128																										
Positive total	972	757	90	41	67	133	0	91	0	24	1 167	104	11	7	76	18	316	579	1 522	215	607	119	2 023	34	186	340
Positive and negative total	1 211	984	117	54	108	233	1	167	0	66	1 668	215	14	8	131	28	521	910	2 544	478	1 104	242	3 458	43	342	586
Number of flights	1 164	424	605	58	546	2 873	507	760	221	1 446	594	467	247	230	107	156	337	347	731	1 311	652	342	1 195	180	829	488
Flight hours	339	298	127	47	140	782	174	100	54	198	351	124	45	23	13	31	203	187	322	357	392	137	208	72	175	342
Nautical miles	39 219	30 818	11 838	4437	12 459	67 855	16 831	9017	5234	17 527	29 909	10 689	3438	1815	1114	2888	18 166	15 642	29 184	33 591	39 317	13 952	18 838	6071	14 032	24 905
Average pressure altitude, ft	165	193	840	2369	664	1 148	2 993	87	953	536	492	11	148	83	144	2377	1 295	658	193	4 982	1 351	3 770	97	929	170	2 691
Average V, knots	116	104	93	95	89	87	97	90	97	89	85	87	77	80	87	93	90	84	91	94	100	102	91	85	80	73
Base, home state	AL	TX	OR	NE	OR	AZ	AZ	TX	MI	TX	VA	TX	CA	TX	CA	AZ	TX	FL	FL	MT	TX	TX	TX	AZ	FL	TX

TABLE III.- Concluded

Derived gust velocity U_{de}, ft/sec	Frequency of occurrence for airplane type -			
	Aerobatic operations	Commuter operations		Float operations
	38	39	40	41
-40 to -44			2	
-36 to -40			4	1
-32 to -36		2	10	1
-28 to -32		5	23	4
-24 to -28		21	87	12
-20 to -24	3	73	317	23
-16 to -20	17	290	1 203	132
-12 to -16	131	1 275	5 079	449
-8 to -12	487	2 972	7 424	368
-4 to -8	148			
Negative total	786	4 638	14 149	990
4 to 8	189			
8 to 12	460	3 165	8 027	322
12 to 16	97	1 624	5 181	295
16 to 20	31	398	1 207	89
20 to 24	12	87	337	29
24 to 28	7	27	85	5
28 to 32	7	15	28	3
32 to 36		1	7	
36 to 40		1	1	
40 to 44		1	1	
44 to 48		2		
Positive total	803	5 321	14 874	743
Positive and negative total	1 589	9 959	29 023	1 733
Number of flights	335	7 378	5 143	1 623
Flight hours	170	2 056	2 684	885
Nautical miles	13 723	274 012	508 180	89 722
Average pressure altitude, ft	1 659	2 324	4 278	2 505
Average V, knots	81	133	189	101
Base, home state	VA	CA	PA	WA

TABLE IV.- MANEUVER ACCELERATION DISTRIBUTION

Incremental normal acceleration, g units	Frequency of occurrence for airplane type -																					
	Twin-engine executive operations											Single-engine executive operations										
	1	*1[1]	*1[2]	*1[3]	2	2A	*3	3[1]	4	5	5[1]	6	7	7A	7B	7C	7C[1]	8	8A	8A[1]	9	9A
-2.3 to -2.4																						
-2.2 to -2.3																						
-2.1 to -2.2																						
-2.0 to -2.1																						
-1.9 to -2.0																						
-1.8 to -1.9																						
-1.7 to -1.8																						
-1.6 to -1.7																						
-1.5 to -1.6																						
-1.4 to -1.5																						
-1.3 to -1.4											1											
-1.2 to -1.3											2											
-1.1 to -1.2					2						3						1					
-1.0 to -1.1	1				0						3					1		3				5
-0.9 to -1.0	0				2			1	1		7					0	1	6				9
-0.8 to -0.9	0		1		4	7		1	7	1	9			3		1	0	6	1		1	14
-0.7 to -0.8	0	1	0		7	10		1	6	0	12			2		0	0	14	3		0	25
-0.6 to -0.7	2	4	0		21	35		3	12	4	24	1	11	2	4	1	29	0			1	29
-0.5 to -0.6	2	10	4	1	42	81	1	12	36	9	56	1	18	2	1	8	77	10			11	31
-0.4 to -0.5	40	36	14	6	96	368	12	36	142	53	146	15	88	1	9	26	98	23	2	2	33	107
-0.3 to -0.4	155	120	37	6																		
-0.2 to -0.3	949	725	172	63																		
Negative total	1 149	896	228	76	174	501	13	54	204	67	263	17	122	5	16	36	234	37	2	2	46	220
0.2 to 0.3	1 225	1 365	384	140																		
0.3 to 0.4	348	383	106	43																		
0.4 to 0.5	80	173	31	15	222	734	56	152	551	199	220	17	252	18	60	47	151	128	27	7	135	179
0.5 to 0.6	24	98	15	6	88	225	36	51	186	58	82	5	81	19	10	24	176	38	4	1	19	113
0.6 to 0.7	4	50	7	6	44	110	5	17	112	26	39	1	39	6	8	8	106	19	3	0	5	51
0.7 to 0.8	2	34	9	5	23	51	7	5	60	9	20	1	19	7	5	2	63	9	1	1	6	34
0.8 to 0.9		14	3	3	23	23	7	4	36	5	11	1	6	2	0	2	52	8	4		1	16
0.9 to 1.0		8	2	2	11	13	1	1	24	1	12		13	3	0	7	18	1			1	12
1.0 to 1.1		6	3	0	10	3	0	1	20	2	2		4	0	0	2	28	4			1	6
1.1 to 1.2		9	0	0	8	3	1		11	3	7		2	2	1	1	14	1			1	4
1.2 to 1.3		3	1	1	7	4	1		3	0	5		2	0	0	1	7	4			1	3
1.3 to 1.4		4	2		6	1	0		2	0	3		1	0	0		8				2	4
1.4 to 1.5		2			3	2	0		1	0	2		1	1	0		0				1	4
1.5 to 1.6					1	0	0		1	1			1	0	0		1					
1.6 to 1.7					1	1	1		3					0	0		2					
1.7 to 1.8					2	1	1							1	1		1					
1.8 to 1.9					2	0																
1.9 to 2.0						1																
2.0 to 2.1						0																
2.1 to 2.2						0																
2.2 to 2.3						1																
2.3 to 2.4																						
2.4 to 2.5																						
2.5 to 2.6																						
2.6 to 2.7																						
2.7 to 2.8																						
2.8 to 2.9																						
2.9 to 3.0																						
3.0 to 3.1																						
3.1 to 3.2																						
3.2 to 3.3																						
3.3 to 3.4																						
3.4 to 3.5																						
3.5 to 3.6																						
3.6 to 3.7																						
3.7 to 3.8																						
3.8 to 3.9																						
3.9 to 4.0																						
4.0 to 4.1																						
4.1 to 4.2																						
Positive total	1 683	2 149	563	221	451	1 173	116	231	1 019	304	403	25	421	59	85	94	627	212	39	9	173	426
Positive and negative total	2 832	3 045	791	297	625	1 674	129	285	1 214	371	666	42	543	64	101	130	861	249	41	11	219	646
Number of flights	464	663	232	25	904	721	202	1 290	1 672	614	202	106	403	34	157	164	317	287	137	150	294	500
Flight hours	578	760	244	41	1 335	597	213	1 427	1 254	563	263	268	402	15	229	150	164	253	162	147	301	423
Nautical miles	219 656	250 447	88 624	15 338	493 292	216 991	39 856	281 300	206 478	86 977	41 586	43 975	62 631	2241	34 419	18 351	19 182	38 678	21 481	20 540	37 136	55 059
Average pressure altitude, ft	24 533	19 887	21 982	27 100	29 905	23 215	11 143	9 914	4 444	4 695	7 411	13 085	7 520	4763	8 047	4 555	3 722	7 346	8 348	5 000	5 539	7 396
Average V, knots	380	329	363	372	369	363	187	197	165	154	158	164	156	145	150	122	117	153	133	140	123	130
Base, home state	FL	NY	NY	NY	IA	OR	KS	VA	WI	VA	CA	NY	MT	VA	NM	DC	NY	ID	MI	TX	IN	ID

*Airplane used as flight demonstrator.

TABLE IV.- Continued

Incremental normal acceleration, g units	Frequency of occurrence for airplane type —																				
	Personal operations											Instructional operations									
	10	10A	10A[1]	11	12	12[1]	12[2]	12[3]	12A	13	13[1]	4A	14	14A	15	12B	12B[1]	12B[2]	16	17	18	18[1]
-2.3 to -2.4																						
-2.2 to -2.3																						
-2.1 to -2.2																						
-2.0 to -2.1																						
-1.9 to -2.0																						
-1.8 to -1.9																						
-1.7 to -1.8																						
-1.6 to -1.7																						
-1.5 to -1.6																	1	1				
-1.4 to -1.5													1				2	0		1		
-1.3 to -1.4						1							0				5	4		0		
-1.2 to -1.3						1							1				8	2		0		
-1.1 to -1.2		1				2		1		3			0	4			10	3		1		
-1.0 to -1.1		0		2		2		1		3		1	2	2	1	3	11	3		13		1
-0.9 to -1.0		0		1		1		3	1	6		13	14	11	2	4	21	5	4	13		3
-0.8 to -0.9		0	1	0		9		6	1	13	1	37	11	36	7	5	30	22	1	38	1	16
-0.7 to -0.8		1	0	6		12		10	2	16	6	70	20	87	24	10	69	53	15	90	3	44
-0.6 to -0.7		4	0	9	1	21	1	23	5	25	5	95	56	188	59	27	156	110	42	213	16	219
-0.5 to -0.6	2	14	1	18	2	37	4	39	4	67	4	224	106	412	124	76	236	218	129	338	36	527
-0.4 to -0.5	29	57	7	83	5	87	12	164	8	232	10	434	185	793	308	127	491	660	304	692	96	1 057
-0.3 to -0.4																						
-0.2 to -0.3																						
Negative total	31	77	9	119	8	173	17	247	21	365	26	874	396	1 533	525	252	1 040	1 081	495	1 399	152	1 867
0.2 to 0.3																						
0.3 to 0.4																						
0.4 to 0.5	90	147	57	347	8	287	66	451	39	478	62	810	631	1 780	646	575	877	1 890	683	1 654	95	1 246
0.5 to 0.6	18	119	16	149	6	155	35	145	20	265	29	590	503	1 017	320	339	828	1 053	349	663	53	572
0.6 to 0.7	3	81	7	60	7	83	17	65	10	147	16	380	329	578	180	223	557	602	193	349	36	338
0.7 to 0.8	4	41	2	28	1	49	11	41	6	81	12	200	198	322	101	130	326	279	122	240	31	175
0.8 to 0.9	0	18	0	14	1	42	4	12	3	56	4	132	109	183	40	90	223	171	64	156	23	135
0.9 to 1.0	1	19	3	10	0	23	2	3	5	29	4	51	80	117	35	47	131	111	47	97	8	93
1.0 to 1.1		6	0	3	1	13	2	3	1	8	5	27	40	60	19	36	83	60	42	76	14	69
1.1 to 1.2		11	0	8		6		1	2	3	1	19	25	28	5	14	61	56	28	54	6	45
1.2 to 1.3		5	0	2		3		1	1	0		7	13	20	4	14	56	38	7	38	2	42
1.3 to 1.4		3	0	2		3			2	3		8	10	11	5	6	24	21	13	28	1	24
1.4 to 1.5		1	0	0		4			0	0		4	6	7	3	3	18	21	3	18	0	13
1.5 to 1.6			0	0		0			0	0		5	16	5	0	6	15	10	6	18	1	8
1.6 to 1.7			0	1		0			1	0		3	6	3	1	5	4	12	7	13	0	6
1.7 to 1.8			0			0				0		2	4	0	0	5	9	9	3	4	1	0
1.8 to 1.9			0			1				0		1	4	5	0	2	5	10	2	4	1	3
1.9 to 2.0			0			0				1		0	6	1	0	3	3	7	2	4	0	2
2.0 to 2.1			0			1						1	6	2	0	2	1	4	1	1	0	0
2.1 to 2.2			0										1	2	0	3	2	2	1	1	1	1
2.2 to 2.3			1										3	0	0	2	0	5				
2.3 to 2.4													2	2	1	0	0	1				
2.4 to 2.5													1			1	0	1				
2.5 to 2.6													1			0	1	0				
2.6 to 2.7																2	0	2				
2.7 to 2.8																1	0	0				
2.8 to 2.9																	0	0				
2.9 to 3.0																	0	1				
3.0 to 3.1																	1	0				
3.1 to 3.2																		1				
3.2 to 3.3																		1				
3.3 to 3.4																		2				
3.4 to 3.5																						
3.5 to 3.6																						
3.6 to 3.7																						
3.7 to 3.8																						
3.8 to 3.9																						
3.9 to 4.0																						
4.0 to 4.1																						
4.1 to 4.2																						
Positive total	116	451	86	624	24	670	137	722	90	1 071	133	2 240	1 994	4 143	1 360	1 509	3 225	4 370	1 573	3 418	273	2 772
Positive and negative total	147	528	95	743	32	843	154	969	111	1 436	159	3 114	2 390	5 676	1 885	1 761	4 265	5 451	2 068	4 817	425	4 639
Number of flights	155	195	264	317	47	373	127	286	53	931	140	627	472	1 433	525	524	508	1 052	748	1 057	190	2 916
Flight hours	225	175	265	131	30	199	81	193	34	782	123	342	282	935	219	311	448	754	494	813	96	911
Nautical miles	31 563	22 436	34 231	12 596	3101	16 836	8222	19 192	3141	75 331	11 290	46 214	23 994	80 902	19 057	25 703	40 524	64 872	37 420	65 991	6962	68 764
Average pressure altitude, ft	6 122	3 513	5 736	4 116	2216	1 174	2413	2 792	1438	3 004	6 755	2 009	1 704	2 380	2 720	2 500	2 387	2 172	1 506	6 905	1999	2 030
Average V, knots	141	128	129	96	103	85	101	100	92	95	92	135	85	87	87	83	90	86	76	81	73	75
Base, home state	TX	VA	CA	CA	FL	FL	FL	SC	FL	SC	UT	FL	IL	OH	TX	NB	IN	IL	SC	CO	CA	CA

TABLE IV.- Continued

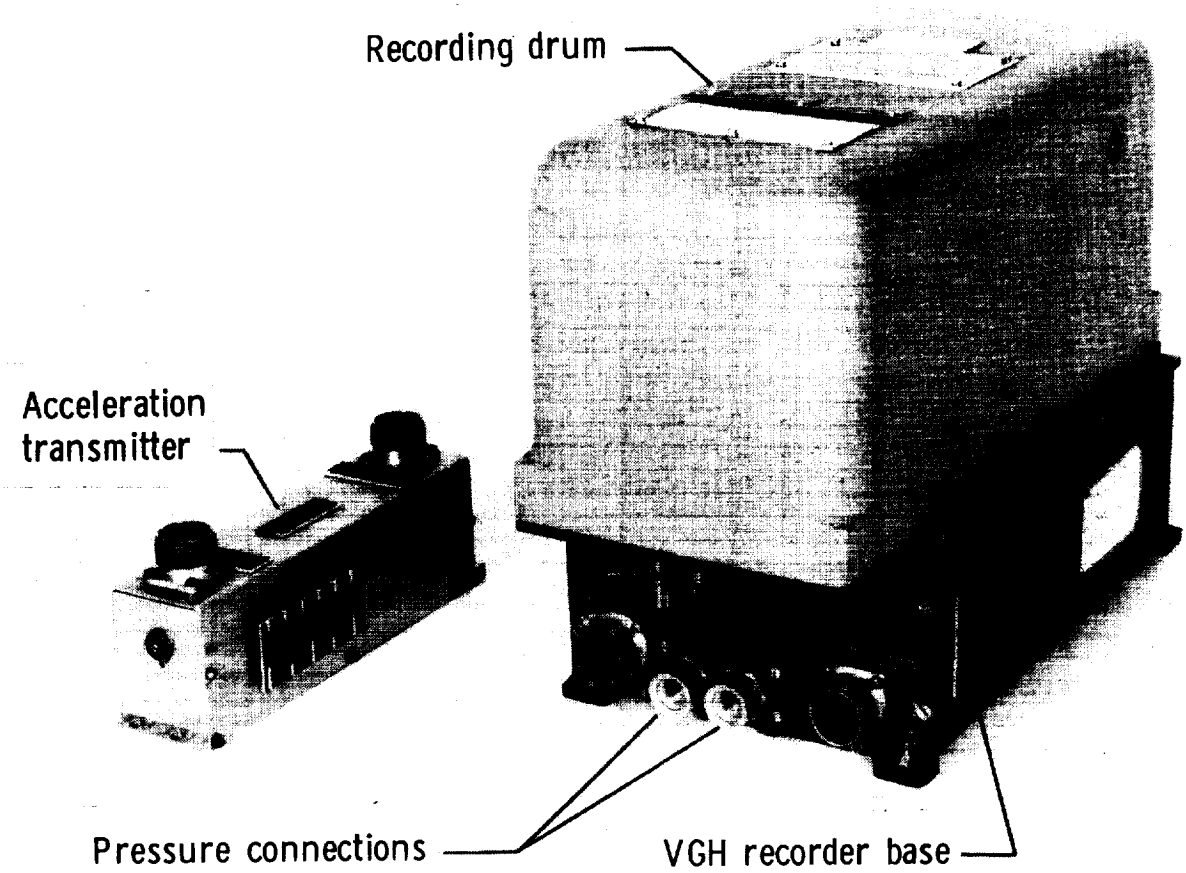
Incremental normal acceleration, g units	Frequency of occurrence for airplane type - Commercial survey operations																				
	19	19[1]	20	20[1]	21	22	23	24	24[1]	24[2]	24[3]	24[4]	24[5]	25	4[1]	26	6A	27	9B	17[1]	28
-2.3 to -2.4																					
-2.2 to -2.3																					
-2.1 to -2.2																			1		
-2.0 to -2.1																			0		
-1.9 to -2.0																			0		
-1.8 to -1.9			1																0		
-1.7 to -1.8			0																0		
-1.6 to -1.7			0																0		
-1.5 to -1.6			0	1															0		
-1.4 to -1.5			0	0									1						1		
-1.3 to -1.4			0	0							1		0						1		
-1.2 to -1.3			0	1	3						1		0	2					1		
-1.1 to -1.2			0	1	5	1		1			3	1	0	0				2	2	1	
-1.0 to -1.1			0	2	8	1		3	2		1	0	0	2				3	3	2	
-0.9 to -1.0			7	3	16	1		3	0		3	2	3	2		1	2	4	1	1	
-0.8 to -0.9			9	22	19	1		4	4	1	1	2	6	5		2	4	10	2	1	
-0.7 to -0.8	2		26	40	31	7		4	4	1	6	1	9	30		9	6	18	1	0	2
-0.6 to -0.7	2		37	53	49	9	1	8	8	6	17	5	36	92	2	64	44	55	5	1	3
-0.5 to -0.6	5	2	81	108	124	43	15	24	21	8	50	31	95	352	4	359	88	104	17	11	2
-0.4 to -0.5	8	6	249	318	241	68	83	68	70	42	124	37	168	726	13	785	172	216	48	31	10
-0.3 to -0.4	50	4	743	803	545	103	251	300	144	145	160	256	128								74
-0.2 to -0.3					1 770																3 221
Negative total	67	12	1 153	1 352	2 811	234	350	415	253	203	367	335	446	1 211	19	1 220	316	412	82	48	3 312
0.2 to 0.3					3 176																4 405
0.3 to 0.4	199	43	1 769	1 748	1 054	247	741	911	616	539	293	686	270								331
0.4 to 0.5	68	99	1 009	964	416	93	451	309	399	184	220	422	306	1 457	65	1 734	1 387	1 019	239	3 314	123
0.5 to 0.6	44	47	427	513	257	53	125	201	183	60	85	240	140	2 031	85	959	1 349	908	78	3 866	41
0.6 to 0.7	26	16	213	295	185	14	48	111	79	23	66	102	62	1 606	64	301	1 094	804	48	3 886	22
0.7 to 0.8	13	7	136	187	105	11	14	75	46	19	33	60	24	1 207	51	114	796	666	36	3 799	14
0.8 to 0.9	7	6	97	105	66	14	5	61	25	12	17	37	22	867	28	53	543	436	22	3 325	7
0.9 to 1.0	6	1	77	84	72	7	3	42	21	18	12	34	18	658	24	19	288	374	19	2 626	2
1.0 to 1.1	3	1	69	63	46	8	0	36	17	15	17	29	18	434	29	14	197	281	9	1 818	1
1.1 to 1.2	1		57	62	33	8	1	32	19	10	9	22	11	287	13	4	79	235	6	958	0
1.2 to 1.3			51	59	62	3		25	11	18	7	15	8	177	11	1	46	201	2	454	1
1.3 to 1.4			31	45	41	8		9	8	9	5	20	3	107	4	1	17	170	5	184	
1.4 to 1.5			13	30	20	4		16	16	10	5	14	8	67	2		6	120	0	62	
1.5 to 1.6			20	26	27	7		11	20	16	6	20	9	31	5		3	104	0	30	
1.6 to 1.7			12	18	9	4		16	12	11	8	11	4	20	0		3	102	0	18	
1.7 to 1.8			9	14	9	1		13	13	12	5	15	4	5	2			82	0	13	
1.8 to 1.9			6	10	8	3		15	6	5	8	10	3	3	0			85	1	11	
1.9 to 2.0			3	6	11	6		14	13	7	5	11	3	6	1			59	1	0	
2.0 to 2.1			4	9	7	2		9	3	5	8	5	1	0				49		0	
2.1 to 2.2			3	2	2	0		11	5	3	5	6	1	0				35		1	
2.2 to 2.3			2	1	1	0		11	4	2	4	3	1	1				30			
2.3 to 2.4			2	1	0	0		7	6	3	4	6	1					39			
2.4 to 2.5			2	0	0	2		10	2	2	1	5	1					19			
2.5 to 2.6			0	1	4	0		10	4		1	1						26			
2.6 to 2.7			1		1	0		6	1		0	3						16			
2.7 to 2.8			0		0	0		5	1		3	1						9			
2.8 to 2.9			0		2	1		3	1		2	0						11			
2.9 to 3.0			1		1			2	0		1	1						8			
3.0 to 3.1								1	1			1						4			
3.1 to 3.2								0	0			0						6			
3.2 to 3.3								3	0			1						2			
3.3 to 3.4								3	1									6			
3.4 to 3.5																					
3.5 to 3.6																					
3.6 to 3.7																					
3.7 to 3.8																					
3.8 to 3.9																					
3.9 to 4.0																					
4.0 to 4.1																					
4.1 to 4.2																					
Positive total	367	220	4 014	4 243	5 615	496	1 388	1 978	1 533	983	830	1 781	918	8 964	384	3 200	5 808	5 906	466	24 365	4 947
Positive and negative total	434	232	5 167	5 595	8 426	730	1 738	2 393	1 786	1 186	1 197	2 116	1 364	10 175	403	4 420	6 124	6 318	548	24 413	8 259
Number of flights	28	28	343	391	304	61	196	248	168	126	120	171	155	169	67	612	277	195	316	492	211
Flight hours	24	24	285	328	305	29	222	78	92	67	67	101	86	246	79	901	545	253	740	1 258	888
Nautical miles	4209	4245	50 316	58 213	53 440	4052	31 242	11 969	13 597	10 222	10 300	16 205	12 302	37 921	12 339	126 142	82 899	31 187	82 334	111 407	54 312
Average pressure altitude, ft	4952	5165	5 015	5 368	5 262	2960	8 162	2 907	2 922	2 835	3 355	2 855	1 954	7 478	6 908	2 870	6 080	5 059	6 895	1 150	1 706
Average V, knots	178	180	176	178	175	141	141	153	147	152	153	161	144	154	156	140	152	123	111	89	61
Base, home state	OR	AZ	OR	OR	OR	CA	ID	CA	CA	CA	CA	CA	CA	NM	ID	NE	WY	OR	OR	OK	VA

TABLE IV.- Continued

Incremental normal acceleration, g units	Frequency of occurrence for airplane type - Aerial application operations																									
	29	29[1]	30	30[1]	30[2]	30A	31	32	32[1]	32[2]	33	33[1]	33A	33A[1]	33A[2]	14	14[1]	14[2]	14[3]	35	35[1]	35[2]	36	36A	37	37[1]
-2.3 to -2.4																										
-2.2 to -2.3																										
-2.1 to -2.2																										
-2.0 to -2.1																										
-1.9 to -2.0																										
-1.8 to -1.9																										
-1.7 to -1.8																										
-1.6 to -1.7																										
-1.5 to -1.6																										
-1.4 to -1.5						1					1						1									
-1.3 to -1.4						4					5						1			2		2				2
-1.2 to -1.3	3				3	103				1	12						4			3	7	1	3			2
-1.1 to -1.2	12	2			7	620	10		2	0	150						10	3	3	8	20	2	10			15
-1.0 to -1.1	67	2		1	6	1 927	37		7	4	523	1			1		24	1	4	64	64	13	22	1		67
-0.9 to -1.0	270	40	14	3	12	3 564	143	2	22	26	1 321	8			0	3	81	4	16	147	190	43	71	41		271
-0.8 to -0.9	588	136	25	19	54	4 987	450	5	56	84	2 351	29		3	0	8	259	13	44	217	548	131	128	98	6	774
-0.7 to -0.8	1 076	413	142	38	154	5 988	1 033	42	96	265	3 352	62	7	11	0	27	485	33	100	349	1 191	321	220	175	22	1 177
-0.6 to -0.7	1 861	937	392	72	443	6 337	1 562	184	219	607	4 650	174	62	21	3	57	826	79	246	642	2 159	591	300	380	86	1 120
-0.5 to -0.6	2 869	1 782	711	99	774	7 484	2 258	485	363	1 027	5 246	325	130	62	11	147	1 196	270	500	1 220	2 995	627	447	413	234	1 028
-0.4 to -0.5	3 192	2 092	1 635	42	1 398	8 750	2 390	959	863	1 142	5 706	682	471	59	44	368	1 319	389	1 503	1 304	3 364	319	525	552	742	1 536
-0.3 to -0.4																										
-0.2 to -0.3																										
Negative total	9 938	5 404	2 919	274	2 851	39 365	7 883	1 677	1628	3 156	23 317	1 281	670	156	59	610	4 206	692	2 416	3 956	10 538	2 050	1 726	1660	1 090	5 992
0.2 to 0.3																										
0.3 to 0.4																										
0.4 to 0.5	2 754	1 513	3 702	77	5 470	11 643	2 955	587	523	1 458	5 269	2 525	1076	37	130	300	1 910	2 541	4 306	3 144	3 044	723	2 050	1204	3 649	3 805
0.5 to 0.6	4 286	2 263	2 965	670	3 037	15 466	4 299	1 178	456	2 216	6 878	2 644	933	242	155	333	3 399	1 712	2 564	5 051	4 628	1 295	3 433	1366	2 444	4 597
0.6 to 0.7	4 680	3 084	2 041	767	1 908	18 074	4 707	1 459	438	2 019	6 687	2 415	907	355	143	341	3 882	1 104	1 780	5 724	6 148	1 463	3 570	1295	1439	6 725
0.7 to 0.8	4 985	3 652	1 288	524	1 220	17 704	4 532	1 370	521	1 879	5 769	2 092	690	292	136	260	3 659	618	1 222	5 693	6 984	1 645	2 557	1114	856	7 727
0.8 to 0.9	5 092	4 068	828	306	575	16 258	3 665	1 382	464	2 089	4 922	1 827	463	287	138	252	3 074	345	759	4 193	7 125	1 670	1 768	777	460	7 864
0.9 to 1.0	4 990	3 979	525	206	280	14 700	2 655	1 351	496	1 936	3 778	1 292	407	226	148	182	2 388	144	430	2 748	7 211	1 448	1 195	533	253	6 456
1.0 to 1.1	4 509	3 528	315	147	137	11 397	1 684	1 119	384	1 840	2 893	779	227	174	143	154	1 488	83	255	1 656	6 030	1 606	692	264	136	4 405
1.1 to 1.2	4 074	2 852	208	80	88	7 231	1 112	1 102	320	1 638	2 276	390	97	142	114	126	744	47	113	964	5 143	1 443	434	135	67	2 766
1.2 to 1.3	3 400	2 072	100	45	71	4 537	569	846	242	1 300	1 952	249	53	109	117	91	481	18	54	524	3 986	1 054	309	79	25	1 735
1.3 to 1.4	2 593	1 451	80	14	49	3 152	268	652	166	1 146	1 655	158	35	70	99	56	189	15	21	351	2 631	941	188	37	15	961
1.4 to 1.5	2 002	1 027	61	8	24	2 187	127	428	150	862	2 068	76	12	50	48	52	92	6	17	153	1 869	556	113	31	2	258
1.5 to 1.6	979	512	31	3	15	1 289	47	246	125	681	1 414	51	5	25	33	19	59	0	0	88	1 261	413	58	17	7	35
1.6 to 1.7	637	241	9	3	5	938	11	168	75	607	1 423	15	0	24	26	16	58	2	2	47	826	291	46	9	3	21
1.7 to 1.8	368	131	7		3	632	4	88	58	498	1 161	14	1	13	34	11	43	0	1	27	568	138	20	4	4	12
1.8 to 1.9	172	63	2		5	361	2	51	34	352	821	6		16	24	7	19	0	1	25	288	70	12	2		7
1.9 to 2.0	78	35	2		3	220		33	37	244	576	6		9	24	4	17	1	2	8	114	32	4	2		3
2.0 to 2.1	34	15			2	92		22	17	169	422	1		6	24	7	11			7	69	18	1			
2.1 to 2.2	14	5			2	50		12	16	103	246	1		3	10		10			5	47	8	2			
2.2 to 2.3	7	3			1	27		5	12	78	168	0		3	3		4			5	25	2	0			
2.3 to 2.4	2	1			1	14		1	9	53	84	1			2		2			8	8	3	1			
2.4 to 2.5	2	1			0	7			7	29	45	1			0		1			4	5	4				
2.5 to 2.6	1	0			0	0			5	16	28				1		2			1	1	1				
2.6 to 2.7		1			0	1			4	13	22						0			1	1					
2.7 to 2.8					0				2	9	10						0				0					
2.8 to 2.9					0				2	3	5						0				0					
2.9 to 3.0					0				0	3	3						1				0					
3.0 to 3.1					0				0	4	2										0					
3.1 to 3.2					0				1												1					
3.2 to 3.3					0				1																	
3.3 to 3.4					1																					
3.4 to 3.5																										
3.5 to 3.6																										
3.6 to 3.7																										
3.7 to 3.8																										
3.8 to 3.9																										
3.9 to 4.0																										
4.0 to 4.1																										
4.1 to 4.2																										
Positive total	45 659	30 497	12 164	2850	12 897	125 980	26 637	12 100	4565	21 245	50 577	14 543	4906	2083	1552	2206	21 389	6 636	11 537	30 427	58 013	14 824	16 455	6869	9 360	47 377
Positive and negative total	55 597	35 901	15 083	3124	15 748	165 345	34 520	13 777	6193	24 401	73 894	15 824	5576	2239	1611	2816	25 595	7 328	13 953	34 383	68 551	16 874	18 181	8529	10 450	53 369
Number of flights	1 164	424	605	58	546	2 873	507	760	221	1 446	594	467	247	230	107	156	337	347	731	1 311	652	342	1 195	180	829	488
Flight hours	339	298	127	47	140	782	174	100	54	198	351	124	45	23	13	11	203	187	322	357	392	137	208	72	175	342
Nautical miles	39 219	30 818	11 838	4437	12 459	67 855	16 831	9 017	5234	17 527	29 909	10 689	3438	1815	1114	2888	18 166	15 642	29 184	33 591	39 317	15 952	18 838	6971	14 032	24 305
Average pressure altitude, ft	165	193	840	2369	664	1 148	2 993	87	953	536	492	11	148	83	144	2377	1 295	658	193	4 982	1 351	3 770	97	929	170	2 691
Average V, knots	116	104	93	95	89	87	97	90	97	89	85	87	77	80	87	93	90	84	91	94	100	102	91	85	80	71
Base, home state	AL	TX	OR	NE	OR	AZ	AZ	TX	MI	TX	VA	TX	CA	TX	CA	AZ	TX	FL	FL	MT	TX	TX	TX	AZ	FL	TX

TABLE IV.- Concluded

Incremental normal acceleration, g units	Frequency of occurrence for airplane type -			
	Aerobatic operations	Commuter operations		Float operations
	38	39	40	41
-2.3 to -2.4	1			
-2.2 to -2.3	0			
-2.1 to -2.2	2			
-2.0 to -2.1	1			
-1.9 to -2.0	0			
-1.8 to -1.9	2			
-1.7 to -1.8	3			
-1.6 to -1.7	10			
-1.5 to -1.6	13			
-1.4 to -1.5	30			
-1.3 to -1.4	46			
-1.2 to -1.3	87			
-1.1 to -1.2	104			1
-1.0 to -1.1	125			1
-0.9 to -1.0	168	1	1	3
-0.8 to -0.9	250	3	3	4
-0.7 to -0.8	340	12	11	13
-0.6 to -0.7	504	17	26	47
-0.5 to -0.6	720	52	85	124
-0.4 to -0.5	502	248	239	482
Negative total	2 908	333	365	675
0.4 to 0.5	198	493	687	238
0.5 to 0.6	486	155	258	104
0.6 to 0.7	379	51	85	30
0.7 to 0.8	386	26	35	17
0.8 to 0.9	254	8	20	7
0.9 to 1.0	232	5	6	3
1.0 to 1.1	202	2	6	2
1.1 to 1.2	223	3	2	1
1.2 to 1.3	218	1	0	0
1.3 to 1.4	212	1	1	1
1.4 to 1.5	246	2	0	1
1.5 to 1.6	195	1	1	
1.6 to 1.7	249	3		
1.7 to 1.8	210			
1.8 to 1.9	217			
1.9 to 2.0	195			
2.0 to 2.1	199			
2.1 to 2.2	200			
2.2 to 2.3	193			
2.3 to 2.4	157			
2.4 to 2.5	165			
2.5 to 2.6	154			
2.6 to 2.7	104			
2.7 to 2.8	103			
2.8 to 2.9	95			
2.9 to 3.0	74			
3.0 to 3.1	41			
3.1 to 3.2	43			
3.2 to 3.3	33			
3.3 to 3.4	35			
3.4 to 3.5	23			
3.5 to 3.6	11			
3.6 to 3.7	9			
3.7 to 3.8	6			
3.8 to 3.9	1			
3.9 to 4.0	1			
4.0 to 4.1	2			
Positive total	5 751	751	1 101	404
Positive and negative total	8 659	1 084	1 466	1 079
Number of flights	335	7 378	5 143	1 623
Flight hours	170	2 056	2 684	885
Nautical miles	13 723	274 012	508 180	89 722
Average pressure altitude, ft	1 659	2 324	4 278	2 505
Average V, knots	81	133	189	101
Base, home state	VA	CA	PA	WA



L-83-108

Figure 1.- NASA VGH recorder.

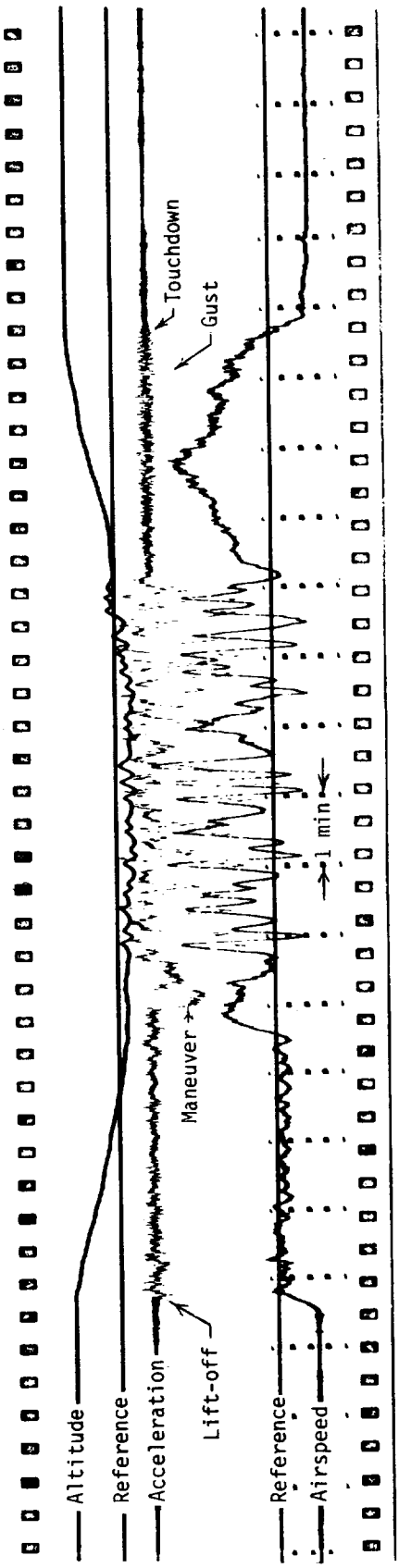


Figure 2.- Sample aerobatic VGH record.

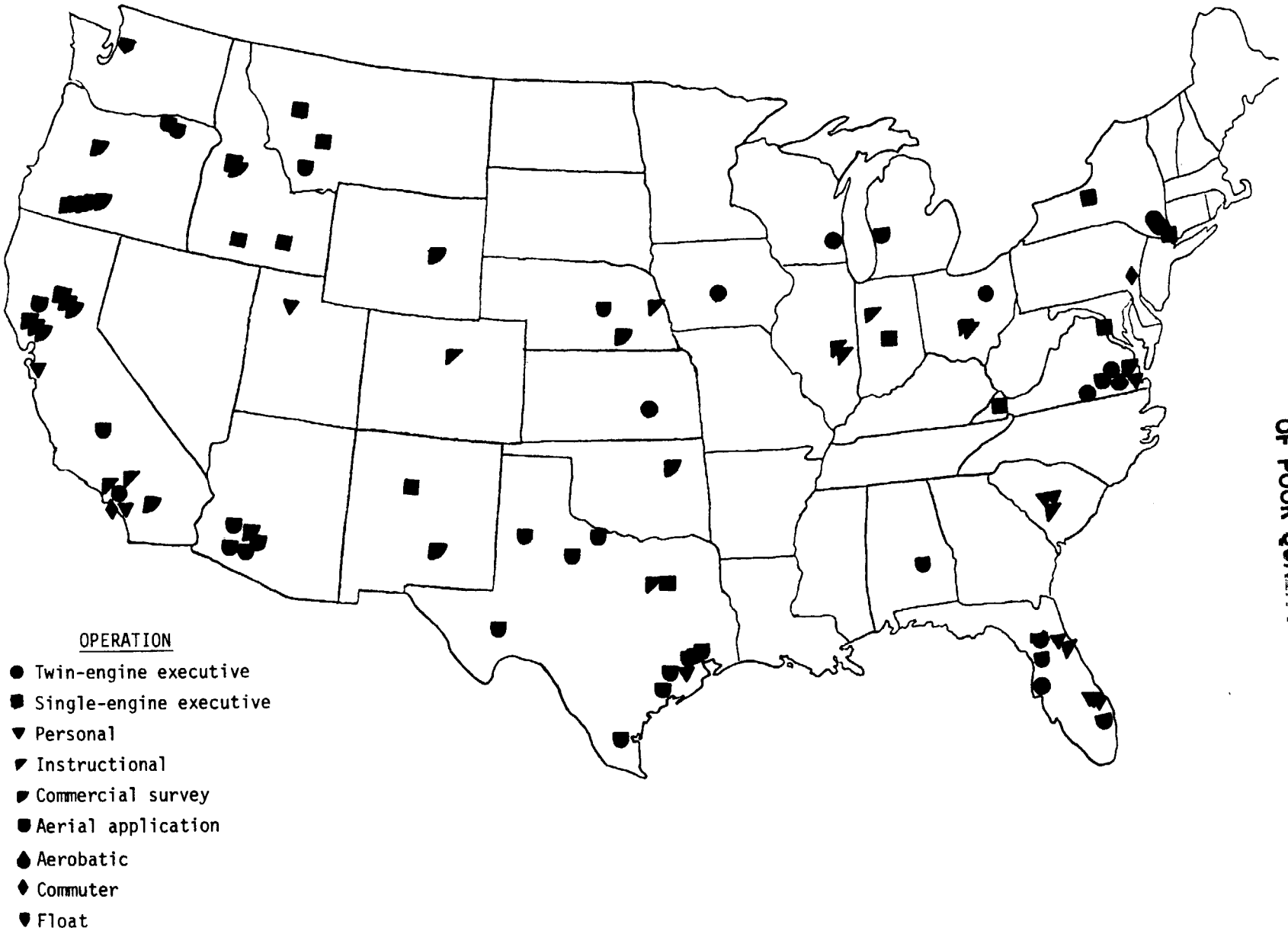


Figure 3.- Map indicating instrumented airplane's home bases.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-84660		

4. Title and Subtitle	5. Report Date
TABULATIONS OF RECORDED GUST AND MANEUVER ACCELERATIONS AND DERIVED GUST VELOCITIES FOR AIRPLANES IN THE NASA VGH GENERAL AVIATION PROGRAM	September 1983
	6. Performing Organization Code: 505-45-03-01
7. Author(s): Joseph W. Jewel, Jr.	8. Performing Organization Report No.: L-15613
	10. Work Unit No.
9. Performing Organization Name and Address: NASA Langley Research Center, Hampton, VA 23665	11. Contract or Grant No.
	13. Type of Report and Period Covered: Technical Memorandum
12. Sponsoring Agency Name and Address: National Aeronautics and Space Administration, Washington, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Tables of incremental gust and maneuver accelerations in 0.1g intervals (above preselected threshold values) and derived gust velocities in intervals of 4 ft/sec are presented for 95 general aviation airplanes flown for 35 286 hours in 9 types of operations.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
General aviation airplanes Derived gust velocities Gust accelerations Maneuver accelerations	Unclassified - Unlimited Subject Category 03

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	31	A03

For sale by the National Technical Information Service, Springfield, Virginia 22161 NASA-Langley, 1983